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AGRICULTURAL SCIENCE REVIEW

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Editorially Speaking . . . .

One of the articles in the last issue of *Review,* "Why Don't Students See Orion?" continues to draw warm, friendly letters from readers who were thoroughly delighted with the piece. We were not at all surprised at this response.

Peterson's article, by the way, was one of the few we've ever published that went to the printer unsullied by editorial marks. How do you correct the prose of your former English professor? How do you improve something that doesn't even have a loose comma?

Incidentally, reprints of "Orion," in reasonable quantities, are still available from the *Review* editorial office. Also we have a limited supply of reprints of "Linguistic Barriers in Science Writing," which appeared in Volume 3, No. 2, 1965.

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Speaking of communications feedback, our staff would welcome letters to the editor that reflect the marrow of this journal's purpose and objectives—critical review and analysis. Do you sometimes disagree with an author's statement? Other readers might like to hear your viewpoint on a topic. Suitable letters will be published in our Letters section; longer pieces will appear in our Forum section. You might keep in mind that your piece will be read by a majority of the agricultural scientists in North America and by quite a few foreign scientists scattered over the globe.

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You have undoubtedly noticed a change in the cover of this issue of *Review.* The antique laid cover stock formerly used is, unfortunately, no longer available from our printer—hence, the switch to a self-cover (same weight and quality as text paper). Whether we keep the present format or change to a different one will depend largely on the reaction of readers.—W. W. K.

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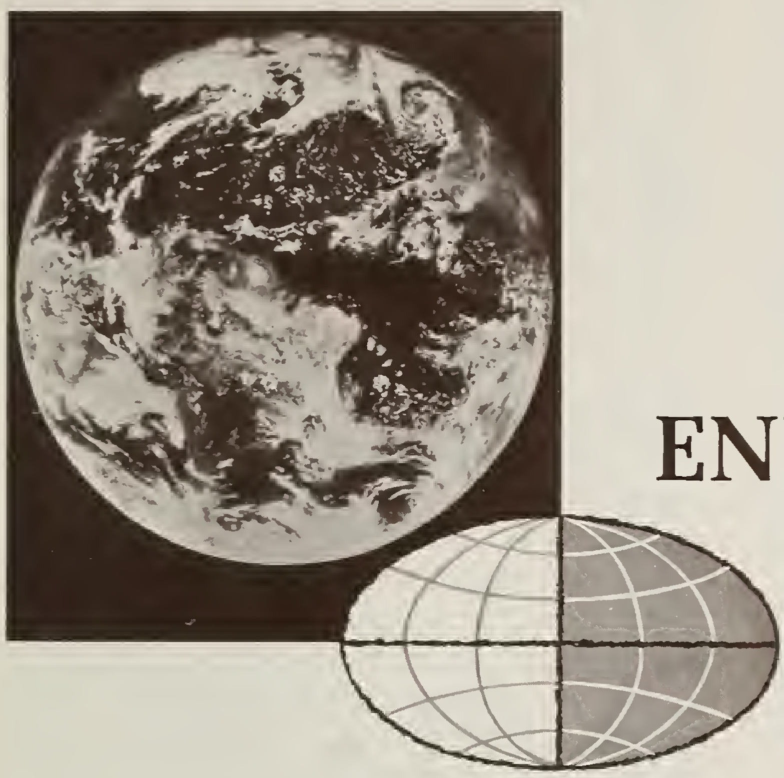


ENVIRONMENTAL QUALITY

A Survey of Attitudes and Problems

QUALITY of environment, a major objective of all agricultural and forestry research programs, is of vital concern to every segment of human society. Oddly, the concept of environmental quality is so recent that there is no widely accepted definition of the term. Yet the absence of quality is easily recognized. In city or countryside, on land, air, or water—everywhere we face the consequences of pollution.

Many stately essays have been written about the desirability of a clean environment. Some of them are shocking, some are thought-provoking, some of them deliberately promise an "all's well" ending. It is not the intention of *Review,* however, to add another such essay to this list. Rather, we will attempt to identify three divergent views prevalent among scientists today and let readers assess for themselves the merits of each. In addition, we will delineate the role of agriculture as outlined recently by Secretary of Agriculture, Orville L. Freeman. This role embodies a deep commitment and responsibility which the Department accepts in improving, protecting, and restoring environmental values in the face of unprecedented demands being made on these values by modern society.

Community of Interest

ACHIEVEMENT of a desirable quality of our environment will depend heavily on a common alinement of purpose, a mutually acceptable standard among all segments of human society—the scientific community, private industry, public funding agencies, and the masses of humanity whose attitudes and practices contribute significantly to the state of our environment today.

One salient point needs to be established at the outset. As long as a decline in environmental quality affects only a given community, people in unaffected communities are not likely to be concerned about the problem. As an example, residents of the little village of Roaring Spring, Pa.—most of them anyway—have learned to live with the pungent odor emanating from the local paper mill. Residents of nearby Martinsburg, however, are generally unconcerned about the problem except on rare occasions when the prevailing wind pattern shifts. But then they take comfort in knowing the air contamination is only temporary.

This article is largely based on the several publications and sources documented in the accompanying footnote references.

An analogous situation can be found in, say, Los Angeles County, Calif. Most residents will grumble about the smog, but continue to live out their natural lives in the area. Those who cannot adjust merely move to another community.

Cities situated along a polluted river have learned how to avoid the consequences of pollution practices of cities located upstream simply by installing purifying systems of their own or by piping in clean water from protected reservoirs. Thus, they may tend to disregard the water needs of cities downstream and accordingly dump their own sewage effluent in the same river.

Concern over environmental quality can assume vastly different proportions, however, when the combined pollution practices of many communities or segments of society begin to affect wider areas or totally unrelated segments of society. Thus, a State or a Nation or a continent may begin thinking about a common course of action designed to halt the declining quality of its environment. Although it would appear that we in the United States have reached this stage in our thinking and action, in reality we have not. Many of our problems related to environmental quality are, in fact—and by necessity—still waiting to be properly identified and evaluated. Do we know, for example, how serious is the problem of airborne dusts, or the problem of nitrate in ground water? True, we are rapidly acquiring data that *seem* to indicate the seriousness of our pollution problems. We know, for instance, that industry releases 17 million tons of dust in the atmosphere annually. But the real problem—simple as it may see—is how much airborne dust can we continue to add to the atmosphere before it becomes a deadly threat to human life.

Although such a viewpoint might properly be condemned as being unrealistic or impractical, it brings into proper focus the magnitude of the overall problem of environmental quality as it affects not just an area, not just a State, or a continent—but indeed our whole planet. As one scientist stated: *How adversely is the cutting of tropical forests affecting the world's oxygen supply? The awesome fact is that we don't know.* Therein lies the gravity of the whole environmental problem. At this point in time, science can only theorize as to the extent of endurance of human life on a polluted planet. It would seem, therefore, that the best approach is to become better housekeepers of that planet—particularly since the *incidence* and the *kinds* of pollution are mounting almost faster than we can document them.

The Widened Scope

CONCERN about the quality of environment dates back almost as far as the recorded history of man. But until recently, however, the associated problems were largely regional and the attempts to solve them were community oriented.

Several early exceptions to this regional approach have occurred in the United States when the problem either reached national proportions or when a few concerned individuals were able to turn indifference into action. One of the most notable examples was the work of Hugh Hammond Bennett, first Chief of the Soil Conservation Service, who dramatized the dust storms of the 1930's as not only depleting the soil on the Great Plains, but also creating enormous pollution of the atmosphere. Bennett really started a crusade that caught the public fancy. His enlightened leadership has done much to enhance one aspect of the environment around us.

Admittedly, some of our pollution problems are too vast and too intimately related to our way of life to be solved by a crusade. We would be reluctant, for example, to give up the use of internal combustion engines to achieve an exhaust-free atmosphere. But some problems might be suited to the crusade approach if the right formula and the right kind of leadership were available. One possible example might be that of highway littering—a widespread practice that not only defaces the beauty of the countryside but also contributes heavily to already costly maintenance programs. It seems quite apparent to many observers that State laws and a catchy slogan have little effect on the whims of litterbugs.

Despite the realization in the 1950's that improvement of environmental quality is a worldwide problem, some hint as to effective modes of action, *on a worldwide basis,* did not become manifest until the advent of the International Biological Program. It seems significant to note that certain aspects of the crusade approach were inherent in the original goals and purposes of IBP—a tribute, perhaps, to the wisdom and foresight of British biochemist Sir Rudolph Peters and Italian geneticist Giuseppe Montalenti, who conceived the idea for the program.

And if we can consider that the IBP marked the turning point in worldwide attitudes toward environmental quality, then it might also be postulated that the so-called Daddario report [1] brought a new meaning and a deeper appreciation of the scope of the problem to those who could logically affect the future welfare of IBP either through more active support or more substantive participation—at least insofar as the U.S. role is concerned.

The Daddario Report

ON the morning of March 9, 1967, Chairman George P. Miller of the House Committee on Science and Astronautics introduced House Concurrent Resolution 273 at the request of the National Committee for the IBP. In summary, the resolution called upon all Federal departments and agencies and all persons and organizations, both public and private, to support and cooperate fully with the program, activities, and goals of the U.S. National Committee and the Interagency Coordinating Committee in carrying out the IBP in the United States.

The resolution was put on the calendar of the Subcommittee on Science, Research, and Development. In May 1967, Chairman Emilo Q. Daddario convened the subcommittee for a 1-day hearing to take the necessary testimony from IBP officials. Since everyone appeared to be in favor of the resolution, its speedy approval was generally expected to be a routine matter.

But the subcommittee soon learned that, although the resolution itself could be readily disposed of, the IBP and the problems it represents could not. Accordingly, the subcommittee decided to extend the inquiry so that additional experts could be called in to document more fully the case for the IBP.

Roger Revelle, then chairman of the National Committee for the IBP, opened the subcommittee's hearings and set the tone for what was to follow with this observation:

"In our times of unprecedented change, biologists are aware of the rapidly growing ability of their fellow human beings to alter the face of the earth through technology. But they are equally aware that these alterations can bring about far-spreading and often destructive changes in the web of life that is stretched so thinly over the surface of our planet. Our technology has outpaced our understanding, our cleverness has grown faster than our wisdom.

"Because of our limited understanding of the relationships among living things, we are limited in our ability to predict the effects of technical change or to help the technologists conserve the values and utilize the abuandance of the world of life. Our goal should be not to conquer the natural world but to live in harmony with it. To attain this goal we must learn how to control both the external environment and ourselves. Especially we need to learn how to avoid irreversible change. If we do not, we shall deny to future generations the opportunity to choose the kind of world in which they want to live.

"Greater understanding will make it possible for man to respond to opportunity as well as to react to need. To gain such understanding is the underlying purpose of the International Biological Program."

The hearings continued intermittently throughout the summer. As the weeks and months wore on, members of the subcommittee began to realize that IBP was not just another international cooperative agreement. Instead, it dealt with one of the most crucial situations civilization has ever faced—the immediate or near potential of man to damage, perhaps beyond repair, the ecological system of the planet on which all life depends.

On March 20, 1968, the subcommittee published a report of its findings and recommendations. One of its major conclusions was that the ecological problem facing the world is, indeed, a critical one. Such an announcement, of course, came as no surprise to the IBP leaders themselves. For it was their testimony that guided the subcommittee in making this statement.

Without the advantage of hindsight, it seems quite likely that the concept and enactment of the International Biological Program will rank as one of the most significant steps the world of science has ever taken. But whether it ever reaches the full bloom of achievement is quite another matter. Even before the program was scheduled to officially get under way, the magnitude of the problems and the financial and manpower burdens these problems would impose on the scientific community began to be felt.

[1] "The International Biological Program: Its Meaning and Needs," Report of the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, U.S. House of Representatives, U.S. Government Printing Office, Washington, D.C., Mar. 20, 1968.

One resulting benefit that must be recognized, however, is that the scientific community—through the medium of the IBP—has succeeded in alerting the world to the possible dangers in the declining quality of our environment. The real problem now seems to be how to achieve a common alinement of purpose among the segments of society as delineated earlier in this article. But as the program begins to take shape, one annoying factor cannot be overlooked—the several divergent views among scientists as previously noted.

Prophets of Doom

OF the recognizable divergent views as to the seriousness of the worldwide environmental quality problem, the most common is the one sometimes described as being in the camp of the "prophets of doom." Their unwelcome prognostications are often challenged and ridiculed, but the fact that they may be correct demands some consideration of their viewpoints. Agriculture's involvement in these viewpoints is far from being a minor one. The March 1968 Wadleigh report [2] documents well the unhappy consequences of the mounting problems associated with waste production and management, many of which are intimately related to biological functions. As might be expected, many of these presaging viewpoints were freely presented during the hearings of the Daddario subcommittee. In its summation report, the gist of such testimony was paraphrased as follows:

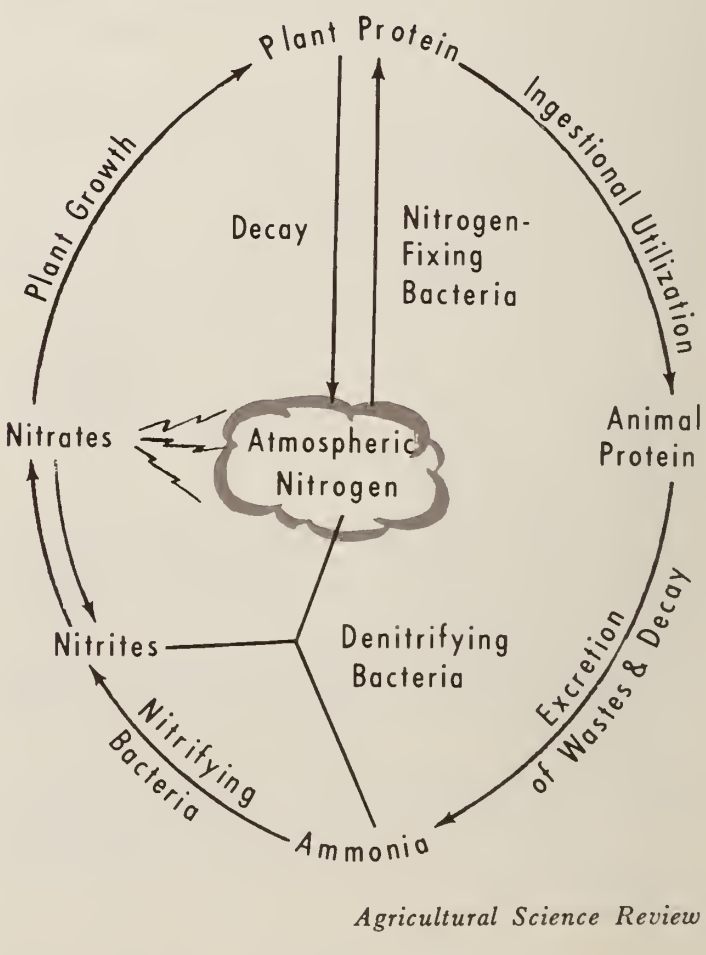
"The need is to find out how, why and what we—humans—are doing to the natural rhythms of earth and to the life and environment upon it. Recognizing the appearance and disappearance of many forms of life throughout the great epochs of our planet's history does not alleviate the problem. For what apparently is happening is that man, through his cunning and acquisitiveness, his desire for comfort and security—and through the technology he has developed to help meet these ends—has engendered the capability to telescope nature; to alter it, to foreshorten it, to accelerate its natural cycles—and very possibly to destroy many of its life supporting characteristics.

"The threat stems from the same power which has set humans apart—the ability to reason, remember, learn, and think in the abstract. This gift, instrumental in the rise of civilization, may also result in the destruction of growing things and their ecosystems before we have been able to learn what the basic relationships between the two are—including not only the growth, consumption and disposal of natural resources, but the climate, the balance and supply of the atmosphere both as to quality and quantity, and so forth; in short, the total environment."

Dr. David M. Gates, Director, Missouri Botanical Gardens, recognized the need to define priorities—the urgency of studying the earth around us:

"Why do we do those things first which are less urgent than others? When will we realize that soon it will be too late to study relatively undisturbed plant and animal communities? Is it more urgent to study the galaxies, the stars, the planetary systems, which will be here a thousand years hence, than it is to study the biota of the terrestrial habitats?

"The terrestrial ecosystems are most susceptible to destruction. The aquatic systems—the oceans, the lakes, the rivers, are next. They have a little longer time constant, particularly the oceans. * * * I am not saying let us not study the stars and the galaxy and the nucleus—we must. But if there has to be a



[2] "Wastes in Relation to Agriculture and Forestry," Cecil H. Wadleigh, M.P. No. 1065, U.S. Department of Agriculture, Washington, D.C., March 1968.

choice, if there is a matter of urgency the terrestrial system, the surface of the earth on which we are living, the thing that surrounds us on all sides. * * * This is where the big changes are. This is where the impact of man is occurring."

The rising incidence of eutrophication was repeatedly cited during the Daddario subcommittee hearings.

"At the beginning of the century the Great Lakes were in a condition that did not differ greatly from that in which they were left by receding glaciers about 11,000 years ago. Normally such bodies of water have a lifespan of about a million years.

"Today, however, Lake Erie is virtually a dead lake, filled with vegetation and debris and nearly devoid of useful fresh water life. Lake Michigan is on its way to the same state, and the other lakes are experiencing shifting temperatures and other signs of adverse change. Again it is man, his multiplication and his penchant for uncontrolled dumping of waste materials or thoughtless use of fresh water, who is responsible for speeding up the natural aging process.

"It has been estimated that if all human polluting activity were halted immediately, about 500 years would be required to restore Lake Erie to its condition of 25 years ago—and about 100 years to bring Lake Michigan back to its condition of that same period—if, indeed this is possible at all."

Months later in a different setting,[3] Dr. Barry Commoner, Chairman, Department of Botany, Washington University, St. Louis, made some observations about what he termed "our unwitting march toward environmental disaster."

"I believe that much of the available basic biological knowledge required for the prudent guidance of environmental engineering and agriculture has not been effectively transmitted to the practitioners of these applied sciences. And given this failure, it is understandable that the applied sciences have tended to regard each environmental problem as an isolated challenge to technology rather than as a symptom of a fundamental biological disorder in the entire environmental system which supports us.

"A second source of our difficulties in understanding environmental problems arises from the failure of communication among the various specialized basic sciences. Thus, the chemists who developed the processes for synthesizing branched-chain detergents might have been forewarned about the ultimate failure of their products if they were in closer contact with biochemistry and bacteriology. The natural environment is itself an integrated system, a complex web, which if stressed at a specific point, usually responds as a whole. Special knowledge of one of its separate parts is an unreliable guide to the behavior of the whole system."

In attempting to evaluate the "prophets-of-doom" viewpoints, the Daddario subcommittee came to the sober conclusion that it preferred to "take as few chances as possible." It further concluded that new data on a total environmental system—such as proposed by the IBP—seems to be "the only way out of the present dilemma which pits alarm versus indifference." In support of this recommendation, the subcommittee cited testimony of Dr. Frederick E. Smith, University of Michigan, which again supported the contention that isolated attacks would fail to solve the overall problem.

"Many of these [environmental] problems are deeply rooted in ecological systems. They are system responses in which the visible effect appears in one part of the system while the cause lies in another. The relation between cause and effect, and recommendations for improvement, would be much easier to determine if the operations of ecological systems were better understood."

Controlled Pollution

A SECOND viewpoint introduces the economic angle and raises the question as to whether society can really afford the attendant high costs of a clean environment. Proponents advocate the systems analysis approach which has been defined in a recent USDA task force report[4] as organized common sense plus modern mathematical tools.

The broad scope of this approach to the environmental problem was well stated by Dr George L. Mehren, Director of Science and Education, U.S. Department of Agriculture.[5] His pertinent comments as cited herein were included in the task force report.

[3] "The Balance of Nature," Barry Commoner, USDA Graduate School Lecture Series, 1967, Washington, D.C.

[4] "Quality of Environment: Pollution in Relation to Agriculture and Forestry," A Task Force Report, U.S. Department of Agriculture, April 1968.

[5] "Aesthetics, Economics—Animal Wastes," Proceedings: National Symposium on Animal Waste Management, ASAE Pub. No. SP 0366, 1966.

"To insist on a clean environment is meaningless. How clean? At what cost? And for what purpose? The right amount of pollution must be planned with criteria set somewhere between the ideal of complete cleanliness and the havoc of uncontrolled filth. The right amount involves a calculated risk to society. It depends on where we are, what use we want to make of the environment and the quality of cleanliness for which we are prepared to pay.

" 'The right amount of pollution' is perhaps a disturbing phrase. It does not mean that we—or anybody else—are going to plan to injure the environment in which we live. It does mean that we shall continue honestly and intensively to identify and analyze benefits and costs. We shall try to minimize hazard or offense; but we shall also try to maintain the living levels and the productivity and the strength of the American economy."

The element of disagreement between those in the prophets-of-doom camp and those who favor controlled pollution actually is founded on a misunderstanding of purpose. Those in the first group tend to feel that the moderation group is willing to settle on a compromise of mediocrity. In reality the moderates undoubtedly aspire to the many advantages of a clean environment as much as any other group. But they have logically concluded that striving for a clean environment at any price represents an economically unsound attitude. Moreover, they point out, the advantages of some degree of pollution—in certain areas—seem to outweight the disadvantages. The Wadleigh report [6] emphasized the importance of a sensible socioeconomic evaluation by asking a series of hard-hitting questions, the answers to which must be sought if optimal economic and social solutions to environmental quality are to be attained.

"How do we define quality of the environment? Where do we draw the line between contamination and noncontamination? How much are we willing to pay for specific levels of quality improvement? Do some segments of society want different levels of environmental quality than others? How do we set up standards that provide flexibility? How do we attach monetary significance to esthetic values? How do we relate these values to quantitative aspects readily evaluated in the marketplace? Do we want to maximize economic benefits, or should we seek to maximize social benefits, or should we attain an optimal combination of the two?"

It seems significant that the proponents of both schools of thought recognize the merits of an integrated approach to the environmental problems which science now finds on its doorstep. As a matter of fact, this approach embodies the whole concept of the International Biological Program—a global plan of environmental research (basic and applied) designed specifically to make a broad and telling contribution to human welfare. In seeking answers of paramount importance to man's survival, the program will indirectly develop the fledgling discipline of ecosystematics—the principles and processes of large environments in their totality (man, vegetation, climate, soils, and animals).

One classic example of man's lack of understanding of his environment became evident as a result of building connecting canals between the Great Lakes and the Atlantic Ocean. The Great Lakes had always been linked together by a system of natural rivers and straits. To this system, man added navigable canals that made it possible for ocean-going ships to travel from the Atlantic to the western end of Lake Superior. But ocean-going vessels were not the only travelers to use the canals. Lampreys and alewives took the same route. Because the lampreys destroyed most of the larger predators, the alewives began to proliferate. As a result, thousands of them have been washed up on the southern shore of Lake Michigan. If a basis for predicting the effect of the canals on the ecology of the Great Lakes had been available at the time of construction, measures could have been taken to avoid or modify this expensive destruction to lake fish populations.

As the USDA task force report [7] pointed out, integrated research, or the systems approach, requires a deep understanding of the practical aspects of pollution and environmental problems. It requires learning by doing and allows adjustments as the program continues. It can prevent crises and emotions from influencing technical-economic decisions. And emotions, of course, are quite likely to be involved where changes in environment are adversely affecting sizeable segments of the human population.

Somewhat the same thought was expressed by Dr. Mehren in speaking as a panel reactor at the USDA Graduate School 1967 Lecture Series:

[6] Op. cit.

[7] Op. cit.

"If we know the biological and physical components of the system alone, we can make no choice. If we impose literary forms of values alone, we can make no choice. If we know the engineering or other costs of the system alone, we can make no choice. The system has three parts and it must be built that way—and with it, I think, we can make our future."

Unpopularity of Environmental Biology

A THIRD divergent viewpoint can be identified as hindering a common alinement of purpose in environmental improvement programs. The Daddario subcommittee cited evidences of it in three different quarters and described it this way:

"Undeniably there is another camp. It consists of those who simply do not care; of those who live where it is not yet possible to appreciate the threat; of scientists who do not want their basic research to be contaminated with social concerns; and of the marketplace which prefers to sidestep the painful economic consequences of any direct confrontation with forecasts of deterioriating environments."

In this regard, *Review* necessarily limits its further commentary to the aspect concerned with the unpopularity of environmental biology. To a certain degree, it seems unfair to hold science accountable for the meager standing of this discipline because what we are faced with is a circumstance of primitive knowledge which hopefully will improve with further discovery.

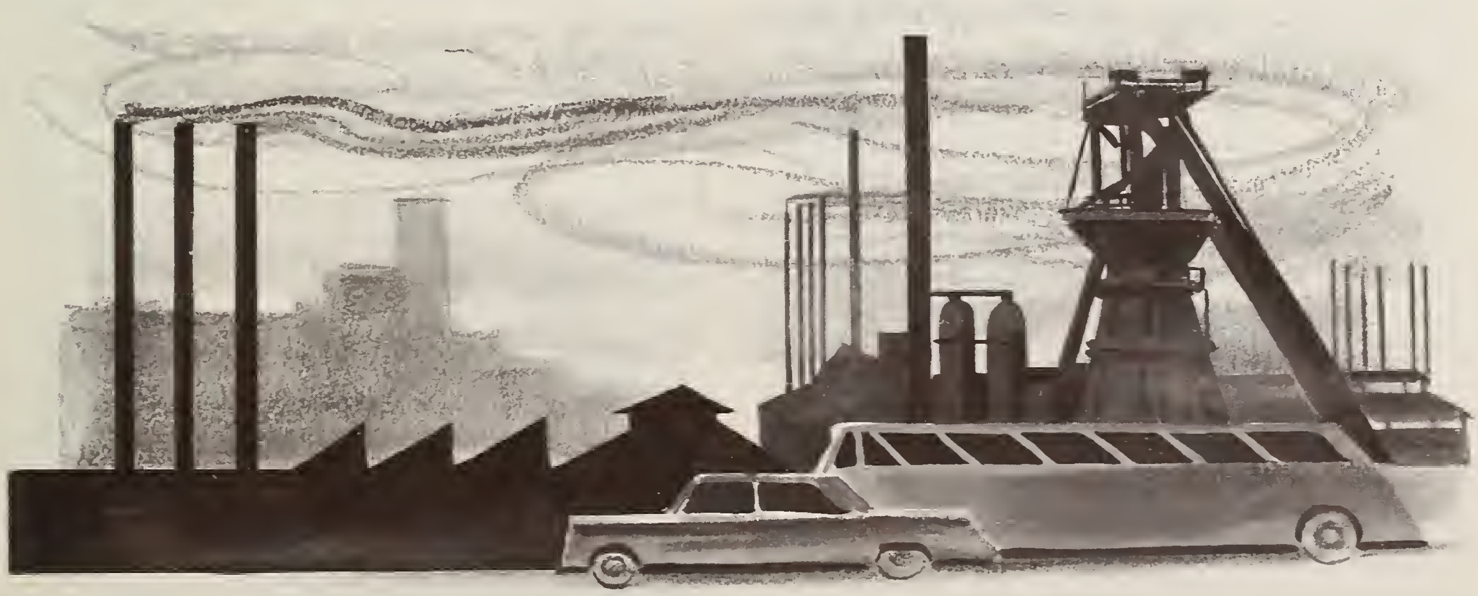
At a late 1967 conference, Dr. Rene J. Dubos, noted biologist and senior scientist, effectively contrasted earlier advances from environmental adaptation to our present primitive knowledge of the threat to health created by our new way of life.[8]

"The most spectacular advances in health during the past 100 years have come from improvements in the interplay between man and his environment. Better sanitation and nutrition, shorter working hours, less exposure to the inclemencies of the weather, and immunization against a few of the most destructive agents of disease are among the changes that have helped modern man to cope successfully with his environment.

"In contrast, knowledge is incredibly primitive with regard to the biological effects of the threats to health created by the new ways of life. Crowding, environmental pollution, indirect and delayed effects of drugs and food additives, constant exposure to a multiplicity of new physical and mental stimuli, alienation from natural biological rhythms, are but a few of the aspects of modern life which certainly affect the well-being of man, and even probably the future of the human race. Yet environmental biology is an almost nonexistent scientific discipline: hardly any effort is being made to develop it, either in universities, research institutes, or medical schools."

Speaking as a witness at the Daddario subcommittee hearings, Dr. S. Dillon Ripley, Secretary of

[8] "Opportunities and Pitfalls," Rene J. Dubos, *In:* Proc. Conference sponsored by the Subcommittee on Government Operations and the Frontiers of Science Foundation of Oklahoma, October 1967.



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the Smithsonian Institution, further explained the situation by pointing out that ecology is not in the mainstream of biology.

"It is particularly difficult to come to grips with broad environmental problems; many of them sound overly intricate, highly theoretical. Some of the ecologists who work on these problems are people who are concerned with such things as mathematical models, and various sorts of stochastic processes in biology which are fringelike; they are not really central to the main efforts in biology today, and they certainly have no large political voice within the scientific establishment. Until there is some understanding of the urgency of this, I do not see that we have a hope of attempting to assess the problem correctly.

"There is an inevitable lack of enthusiasm by even the brightest biologists for activities which are not going to be financially or career rewarding. Environmental problems are not necessarily those which have an accepted and relatively easy success pattern, as let's say, molecular biology has at the moment."

Biologists are continually emphasizing the viewpoint that a survey of an ecosystem, no matter how detailed, will not produce the information needed to solve our environmental quality problems. The main hope, as expressed by Barry Commoner,[9] lies in lifting our sights above the level of molecular biology to encompass a broader study of the natural biological systems around us.

"Biology has become a flourishing and well-supported science in the United States; it is producing a wealth of new knowledge, and is training many scientists skilled in its new methodology. But modern biological research is now dominated by the conviction that the most fruitful way to understand life is to discover a specific molecular event which can be identified as 'the mechanism' of a particular biological process. The complexities of soil biology or the delicate balance of the nitrogen cycle in a river, which are not reducible to simple molecular mechanisms, are now often regarded as uninteresting relics of some ancient craft. In the pure glow of molecular biology, studying the biology of sewage is a dull and distasteful exercise hardly worth the attention of a 'modern' biologist. * * *

"The systems which are at risk in the environment are natural; and because they are natural, complex. For this reason they are not readily approached by the atomistic methodology which is so characteristic of much of modern biological research. Any new basic knowledge which is expected to elucidate environmental biology, and guide our efforts to cope with the balance of nature, must be relevant to the natural biological systems which are the arena in which these problems exist. And if basic biological research is to be relevant to natural systems, it must recognize that these systems need to be studied, not as an assemblage of isolated parts, but as integrated wholes."

The Role of Agriculture

It has already been well established that the role of the agricultural sciences in environmental improvement programs seems destined to be a major one. One cannot read the Wadleigh report without sensing the deep involvement of agriculture in a multiplicity of endeavors hardly thought of a decade ago. Although the progress already being made offers some encouragement, the enormity of the tasks ahead tends to minimize past achievements.

No longer is agriculture concerned only with producing and distributing more and better food for more people. The challenge has broadened to include the problem of how to provide living space for a population that seems certain to double in a single generation—bringing with it an added strain on all environmental resources.

Within such a setting and context, therefore, Secretary Orville L. Freeman decided on a course of action designed not only to identify the Department of Agriculture's broadened responsibilities but also to enumerate specific activities by which the Department might carry out its overall commitment. The Secretary's Memorandum No. 1631, dated March 19, 1968, lists six areas of opportunity to which priority will be given.

1. *Reduction of the Damages and Losses from Pollution* to soil, water, and air by agricultural chemicals, crop, livestock, and forestry wastes, sediment, sewage, and mining operations. The Department will continue to work with other Federal, State, and local agencies to minimize air and water pollution from urban and industrial sources.

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[9] Op. cit.

2. *Revitalizing Rural Communities* through effective, balanced use of human talents and natural and economic resources to achieve more jobs, with more income for more people. The goal is to build communities of tomorrow that can reverse the present trend toward metropolitan congestion and help attain a rural-urban balance in which man can live in harmony with his environment.

3. *Maintaining and Improving the Quality of Rural Living* as an attractive, healthful place to live, through increased assistance providing equally to all people the services and amenities of contemporary life—such as housing, water supply, waste disposal, power, communication, transportation and education.

4. *Expanding Outdoor Recreation* to help meet the public demand, and to create jobs and strengthen the economy of the countryside. The Department will expand recreational facilities in the National Forests and provide financial, technical, and educational assistance to rural communities, farmers, and others to establish or enlarge such facilities for public use.

5. *Enhancing Natural Beauty* through landscaping, screening of residential and industrial developments, rehabilitation of surface-mined lands, protection of soil and plants, and conservation activities generally.

6. *Protecting Public Health* in both rural and urban areas by controlling pests that ravage food crops and livestock, and transmit human diseases, guarding the wholesomeness and quality of food products against contamination, reducing pollution of soil, water, and air, and providing and improving sanitation and waste disposal systems in rural areas.

* * *

Agricultural scientists and administrators will, of course, have to decide for themselves the extent of their own involvement and that of their affiliated organizations. Viewpoints will be adopted, and these will, in turn, tend to temper and guide courses of action. One thing seems certain, however: The scope and stature of agriculture's role in environmental improvement will be measured largely by the degree of unanimity the various sectors decide upon. For a while, at least, environmental pollution can conceivably be ignored. But for how long—that, we do not know.

On Natural Areas and Human Needs

MAN evolved in an environment that consisted of the natural biota, and even though he now lives amidst concrete and steel, he still feels strong ties to those elements of the biota with which he evolved. For some people, at least, the ability to get back to nature is an important factor in maintaining mental and emotional health.

It seems reasonable to assume that, no matter how sophisticated our technology may become, we will still want and need parks, open spaces, forests and wilderness. With our exploding population and increased affluence, we are using more and more of our open spaces for residential and recreational pursuits. In the period 1959 to 1964, for example, one Wisconsin county (Dane) lost 29,923 acres of farmland and 3,109 acres of woodland.

In addition to the decline in quantity, there is also a decline in quality. The natural biota are considered to be a renewable resource—that is, they can be harvested or otherwise disturbed, and will regenerate themselves. This is true only to a degree. Disruption of the natural communities can result in irreversible changes. The most obvious of these is the extermination of species.

If we are to continue to enjoy a natural element in our environment, we cannot continue our present practices. Careful management of our remaining natural resources is imperative; research into the impact of man on the landscape should be accelerated. We do not have an adequate inventory of natural resources, let alone a knowledge of the effects of man-made changes upon the world—the environment—around us.

Grant Cottam, Professor of Botany
From: *UIR/Research Newsletter*
The University of Wisconsin 2:4, 1967

FOOD AND POPULATION: An Overview

IVAN L. BENNETT, JR.

IN February 1966, President Johnson directed his Science Advisory Committee to make a comprehensive study of the world food supply. Shortly thereafter, a panel was appointed to carry out the President's directive. The author of this article, Dr. Ivan L. Bennett, Jr., was chairman of that panel, which, in 1967, published the results of its yearlong study.

Dr. Bennett's appointment to the chairmanship was unique in two respects: Up until that time his entire professional career had been devoted to the study of medicine. Furthermore—and by his own admission—he "had no realization of the all-encompassing urgency of the problem and utterly no conception of its true complexity."

In order to understand the project and to communicate with his colleagues, Dr. Bennett undertook, on a crash basis, home studies in agriculture, the modern history of foreign aid and economic development, trade policies, rural sociology, demography, and econometrics. Thus prepared, and with the added advantage of a clear, objective viewpoint, he guided the panel to a prompt and successful consummation of its task.

This overview is more than a mere summary of the panel's lengthy final report. It includes the kind of profound observations that come only with the hindsight and thoughtful reflection of one who has deep personal convictions about a problem to which he has been thoroughly exposed. The article was adapted from an address Dr. Bennett presented at the annual meeting of the Food and Nutrition Board, National Academy of Sciences, Washington, D.C., November 3, 1967.

In his introductory comments, Dr. Bennett remarked about the difference in public attitude toward medicine and toward agriculture. This difference in attitude, he is convinced, has been of major importance in the development of the world food problem and will be a most important consideration in achieving support for the programs required to alleviate it.

MOST Americans look upon the practice of modern medicine as a highly scientific profession. Most of them would not think of arguing with or second-guessing a physician (unless it concerns his bill) or seek the advice of amateurs in medical matters. Without arguing this attitude on its merits, I would contrast it with that toward agriculture. Most individuals assume that they are, or could easily become, knowledgeable in agriculture—because they equate agriculture and farming which they believe requires only soil, seeds, and perhaps a little fertilizer, plus hard work.

Millions of Americans work in gardens as a form of exercise and they equate what I now call subsistence horticulture, which is always a money-losing proposition, with commercial farm production which is not primarily a recreational pursuit. The best garden usually belongs to the man who works hardest in it or who can afford to hire someone to work in it. This immediate perception of productivity as being related to physical labor is easily transferred to public thinking about the world food problem.

Hence, one encounters the view that the inability of subsistence farmers in the traditional societies of the developing nations to produce the needed food is a sign of either laziness or ignorance. The substance of agricultural science, its possibilities and limitations, and the importance of inputs, adaptive research, the market structure, transportation, processing, storage, and distribution systems do not enter into popular thinking about the problem. All are so taken for granted here that the existence of this so-called infrastructure is assumed everywhere. After all, people must eat and they have been able to eat through the centuries no matter how primitive their economy or how underdeveloped their science. So why don't the farmers overseas just get down to work?

The situation is not nearly that simple. The world food problem is not merely a matter of projecting caloric and protein requirements for the future, or of estimating needed fertilizers, pesticides, and farm machinery to meet these requirements, or of estimating the capital cost of providing these to the developing countries. Instead, the scope of the task leads us to four major conclusions.

1. *Unless the situation changes markedly, food shortages and actual famine will occur.*—This must occur when external aid, in the form of food shipments from the developed nations, can no longer buffer the needs of the hungry countries, and if they continue to be incapable of providing food for their peoples. I am not prepared to even guess when this time may come. There is reason to believe that the ability of the United States and other food-exporting countries to produce grain in the quantities required is not likely to be decisive. The ability of the developing countries to pay, the ability or willingness of the developed countries to subsidize, or the overwhelming logistic problem involved in transporting the tonnages involved are more likely to determine the limitations of external provision of food to the countries which need it. If one merely looks at Indian requirements for grain from abroad this year, the countrywide distribution of the imported food requires moving, every hour of the day and night, a train of more than thirty 40-ton American boxcars or more than 100 of the smaller Indian vehicles known as "goods wagons."

2. *Increased food must come from farming.*—Although nonagricultural sources of food cannot be overlooked, the bulk of the increased food needs for the developing countries will have to come from agricultural production within these countries themselves.

3. *Population control alone is not a solution.*—During the next 20 years, food needs will more than double in the hungry countries if present rates of population growth continue. Optimistic estimates of success in family planning in the next 20 years will only reduce food needs by 20 percent—a significant fraction, but not a solution. The effects of successful family planning will become more apparent in the years after 1985 if programs are initiated *now*. In short, the impact of population control will be realized over a period of many years but there is an immediate and increasing need for food regardless of what happens ultimately in programs of population control.

4. *There is still hope.*—If agricultural technology is improved in the hungry nations, the situation is still reversible. This can result only from programs of technical assistance designed around adaptive research.

Conditions in Developing Countries

THE critical need for food can be illustrated by pointing out that even to feed the people already

born in the developing countries will be an enormous problem because of the large proportion of children in their populations. The amount of food required, of course, increases steadily from the time of birth to about 19 years of age. Nearly half of those living in the developing countries are less than 15 years old. To maintain the Indian population at its present level of nutrition would require 20 percent more food in 1975 than in 1965 if no new children were added during this 10-year period. To elevate the diet to the minimal standard, recommended by the United Nations Food and Agriculture Organization, a 30-percent increase would be required. To bring about each of these caloric increases, in terms of wheat, would require 20 to 30 million metric tons, respectively, each year by 1975—two to three times the present amount of our food aid shipments to India and about the increase that can be expected from recent trends in Indian agricultural production.

Throughout the developing countries of Asia, Africa, and Latin America, reliable figures on how much of a given food commodity has been planted, harvested, stored, or lost to pests and spoilage are still lacking. Nor do we know today whether the population of Mainland China is more than 460 million or less than 790 million people.

In the developing countries, until now, the technological revolution has had only one critically important effect—a striking reduction in death rates. For example, in Ceylon, primarily as a result of malaria control programs, the death rate in the 3 years between 1945 and 1948 fell by as much as it took Western Europe 300 years to accomplish. This reduction in mortality was not accompanied by a proportional reduction in birth rates. Consequently, the unbalanced benefits of modern public health have created something unprecedented in man's history—very high rates of population growth over ancient settlements.

A Lagging Economy

PERHAPS the single most fundamental conclusion that has emerged from the study of the World Food Panel is the realization that hunger, malnutrition and the so-called population explosion are not primary diseases of the developing countries. Rather, they are the symptoms of an underlying malady—lagging economic development. Until the rich nations and the poor nations make a commitment to long-range, coordinated action, dedicated to the systematic solution of a series of interrelated problems—none of which can be solved in isolation from its fellows—the situation will continue to worsen steadily.

As a nation, the United States entered the economic assistance field in earnest under President Truman's famous Point Four, fresh from the successes of the Marshall Plan in Europe. In Europe, however, there already existed long-established, highly developed credit institutions for banking, marketing, transportation, and agriculture. There was no shortage of seasoned managerial talent and there was a large reservoir of skilled workmen ready to man the machines as soon as they could be provided.

In the developing nations, however, the job has turned out to be tough and incredibly more complicated, difficult, and prolonged than anyone imagined in the beginning. This new task, we found, did not entail merely the restoration of a bruised economy like our own, but required the building of a new structure from the ground up.

In agricultural development as well as in other areas of assistance to a developing country, the political stability and predominant attitudes of the recipient government are of crucial importance. Most American citizens are thoroughly familiar with the constraints and disruptions that domestic political conditions within a developing country can create for aid programs. Recent history is replete with episodes which try our patience and frustrate our good intentions.

The receptivity and toleration of people and their political systems require mutual calculation and recalculation. The rates and magnitudes of U.S. economic assistance programs have been said to "run headlong into 19th century banking systems, 18th century commercial codes, corporate arrangements based on familial ownership, and investment attitudes of a low-risk, high-yield, short-term nature like mercantilist 17th century England."

These conflicting elements of many centuries make it clear that the world is unlikely to obey Richardson's architectural prescription that form should follow function. During the past two decades we have had many lessons in accommodating ourselves to the unwelcome facts that what we call *leadership*

may be viewed by others as *exploitation,* what we call *help* may be viewed as *interference,* and what we call *assistance* may be viewed as *intervention.* We call it the Rio Grande; the Mexicans call it the Rio Bravo. We consider ourselves to be a Good Neighbor; many of them think of the "Colossus of the North."

The hard fact remains that despite expenditures of billions of dollars for foreign aid; despite donations and concessional sales of millions of tons of food to developing nations; despite herculean efforts by numerous voluntary groups; despite examples of highly productive technical assistance programs by foundations; and despite years of activity by international organizations, there are today in the world more hungry mouths than ever before in history. There are several reasons for this.

No Simple Solutions

THE problem of population-food imbalance is extremely complex and its dimensions are overwhelming. At first glance, however, it seems deceptively straightforward and is, therefore, unusually susceptible to oversimplification. The temptation to act on the basis of superficial or incomplete information has been irresistible and has led to seizure upon panaceas and piecemeal solutions which are inappropriate, inapplicable, ineffectual, and inadequate. The cumulative delays engendered by false starts and stopgap measures have masked the broad needs for comprehensive programs.

Food shortage and rapid population growth are separate, but interrelated problems. The solutions, likewise, are separate, but related. The choice is not to solve one or the other; to solve both is an absolute necessity. The current tendency on the part of the public to think of food production and fertility control as alternative solutions to a common problem is dangerously misleading.

The twin problems of food and population have one feature in common that adds immeasurably to the difficulties of achieving control. Their eventual solution is crucially dependent upon success in convincing millions of citizens in the developing nations to take individual action. Fertility control cannot be achieved by declarations of government policy or by executive decree, although adoption of a policy and the provision of information, instruction, and materials are obviously needed and are helpful. Similarly, political declarations concerning agricultural productivity are ineffective unless individual farmers can be convinced to adopt the necessary improved practices. The provision of these personal incentives is a task that encompasses a vast array of social, economic, and political considerations which differ between countries and within countries. Indeed, the very fabric of traditional societies must be rewoven if the situation is to change permanently.

In contrast to the more obvious and better publicized difficulties at the political level which I have already alluded to, the obstacles posed by traditional culture, social structure, religious beliefs, and the long-established habits and customs of many developing countries are rarely considered in truly realistic terms. To understand, much less to accept these constraints, is particularly difficult for Americans who remain among the citizens of Western Nations the least cosmopolitan and least tolerant of delay.

Unless farmers in a traditional subsistence agriculture can be persuaded (that is, can be supplied with incentives) to use fertilizer, pesticides, seeds, and other modern inputs to increase output, all other efforts to increase food production will fail. Until a "cash flow" can be generated at farm level, agricultural development will be stymied. Inputs cost money; farmers need credit to buy them. Farmers need to be able to sell their products at a price that will enable them to pay for inputs and have something left besides. When price policy holds

down food costs for the consumer, the producer may not get his share and hence, may see no reason to produce beyond the immediate needs of his family. In many developing countries, the lands are cultivated by tradition-bound peasants who are controlled by a political system which has its power base in cities and is unfamiliar or unconcerned with problems of farming or with the measures, including price incentives, needed to increase agricultural productivity.

You are all at least somewhat familiar with the recurrent difficulties of assuring adequate payment to farm producers in the United States, particularly since modern technology has reduced the number of farm workers and, hence, their political base.

Many of Soviet Russia's difficulties with agricultural production are related to farmer incentives. Even when farmers can make a profit, unless consumer goods which they wish to purchase are available, the money means little to them. One of the persisting Soviet problems (although by no means the only one) is to make consumer goods available in the rural areas. This need is but one of the many reasons that the agricultural and industrial sectors must grow together in developing countries. They are complementary, not competitive.

Farming is a business and, in the last analysis, the rate of increased production in agriculture is determined by effective market demand. In other words, it costs money to produce food just as it costs money to produce any other commodity and someone must pay the bill for an increase in output.

Because of the interdependence which exists among food need, food demand, overall income, agricultural output, and total output (which is GNP), it is meaningless to consider a nation's demand and supply of foodstuffs independently from overall economic growth.

The very nature of farming must be understood if appropriate measures are to be developed in the hungry nations. Farm production is based upon the growth processes of plants that utilize solar energy through photosynthesis. Because the basic process of farming depends upon solar energy, it must always remain widely distributed over the face of the earth so the sunlight can be utilized where it falls. No other single fact has greater significance for agricultural development.

An extensive and well-articulated transportation system is required to move the production inputs from distant points of manufacture to each farm and to move farm products to ultimate consumers. Furthermore, farming lacks two opportunities that are available to many other industries: (1) The opportunity to concentrate activities so that adjacent industries can exchange products, avoiding major transportation costs or time-lags, and (2) the opportunity to create favorable working conditions without transforming an entire society. A steel or textile mill can establish working conditions in a plant which, during working hours, will separate laborers from the demands, customs, and traditions of their families. Agriculture cannot do this since farming must be carried on in widely dispersed village settings, in the midst of family influences and traditional social pressures. Agricultural development, by virtue of this inherent dispersal, requires a major social transformation. It cannot create in part-time oases the new sets of working conditions appropriate to its production needs.

The relationship between transportation and the ability to grow and market food has been demonstrated repeatedly. When the 100-mile long "Friendship Highway" in Thailand reduced travel time from 11 hours to 3 hours, production of sugarcane, bananas, and other fruits more than tripled in 3 years and Thailand began to export corn to Japan.

In advanced Western countries, there are from 3 to 4 miles of farm access roads per square mile of cultivated land. In India, the average now is 0.7 mile and it will require about 1,000,000 miles of access roads to satisfy the needs of the 580,000 villages throughout the country. Only 11 percent now have adequate roads and one out of three is more than 5 miles from a satisfactory road.

Finding the Answers

GIVEN the opportunity, agricultural scientists and technologists can apply existing principles and concepts to find answers to problems of expanding agricultural productivity in another country or region of the world. But the ability to find answers through basic and adaptive research and through technological innovation within a country is distinctly different from already knowing the answers.

While, at first glance, the difference in knowing how to find answers and in already having answers may seem to be a minor one, it has major implications for the inclusion of technical assistance in any

program of agricultural development overseas. Particularly in the field of agricultural development, technical asistance is essential to achieving the ultimate objective of foreign aid, namely, self-sustaining economic growth.

The feeling still persists in many quarters that research or science is a sort of luxury or prestige activity which has no substantial place in a program of aid to developing countries. Quite apart from the fact that adaptive research is an absolute prerequisite to the use of modern agricultural sytems in different regions of the world, the basis for continuing agricultural productivity in any country, including the United States, is continuing research. Research in modern agriculture is a never-ending task.

Improvement of agricultural production by modern scientific methods consists of adapting plant varieties, pesticides, fertilizer usage, and cropping techniques to the local soil and climate. In other words, a "package" is tailor-made for the locality by applying scientific principles to find the answers to local problems. Just as one size of uniform cannot be expected to fit all soldiers, no single set of agricultural technology can be transferred successfully to another country without tailoring it by adaptive research. Furthermore, the adaptive research and testing must be carried out in the country or region where crop improvement is desired.

The failure of most of us, including policymakers in government, to distinguish between the ability of agricultural science to find answers and already knowing the answers has led to insufficient emphasis upon technical assistance as opposed to "practical assistance."

For example, a so-called farmer-to-farmer program has been proposed and enacted into law in the well-intentioned but quite erroneous belief that American farmers could be sent overseas to teach farmers in the developing countries how to increase farm production. Without the scientific and technological backup routinely available to them in the United States, these farmers would be helpless to change conditions elsewhere.

Agriculturalists have repeatedly tried to correct this "know-how, show-how" fallacy by saying that what works in Kansas won't work in Karachi. But the message has not yet penetrated foreign aid policy to the required extent. The notion that research is an absolute necessity rather than an academic diversion is very slow to disappear from popular thinking about foreign aid.

The Population Problem

THAT reduction of population growth is essential to achieving a balance between food supply and food need is an obvious, easily understood, and widely appreciated fact.

There is another, more complex, less well-known and crucially important relationship between nutritional needs and family planning. Surveys of the attitudes of married couples in developing countries show that the numbers of children desired are higher than in the developed nations. Furthermore, the average number of live births per woman in

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these countries is 30 percent greater than the number of children desired.

Emphasis on the desire for heirs leads to large families. Only one son may be needed for ritual or economic purposes but it is common to want two sons to insure against death or incapacity of one. Couples must average four children to obtain two sons.

Availability and efficacy of pills, intrauterine devices, and other technical means of birth control are largely irrelevant until couples have secured the desired number of living children.

If we assume that the necessary preconditions for reducing fertility are low infant and child mortality and a public awareness that mortality is low, then we have the apparent paradox that a reduction in childhood mortality will reduce rather than raise the rate of population growth.

In the United States about 25 out of every 1,000 liveborn infants fail to survive to the age of 1 year, and most deaths are from prematurity or congenital defects. In the poor countries of Asia, Africa, and Latin America, published infant mortality rates range from 100 to 200 per 1,000 live births. Much of the higher death rate is the direct or indirect result of protein-calorie malnutrition.

Protein-calorie deficiency in the form of kwashiorkor is a great killer. Acute diarrhea can be a dangerous illness for a well-nourished American baby; in the malnourished infants of the developing countries, it has an appalling mortality. Common childhood diseases are catastrophic in protein-deficient children. In 1960, for example, the fatality rate from ordinary measles was more than 100 times greater in Chile than in the United States.

If lowered infant and child mortality is a precondition to acceptance of family planning and if the major underlying cause of childhood deaths is malnutrition, it follows that an increase in both quantity and quality of food is essential to achieving stabilization of population growth.

Viewed in this light, alleviation of the world food problem must be accorded the highest priority in planning for the developing nations.

Mandate for Action

UNTIL technical assistance programs have been successful in establishing within the developing countries the institutional and manpower bases for continued research in agriculture, in health, in all aspects of physical, biological and social sciences, and in administration, management, and techniques of diffusing knowledge—no amount of capital investment alone will succeed in bringing about self-sustained economic growth in these nations.

There are three distinct but related reasons for a U.S. program to assist overseas economic development:

First, a humanitarian reason.—We should help the less fortunate simply because they need help and we are able to help them. The benefits of altruism are by no means unilateral. The challenge of a difficult task and the moral uplift that comes only from doing for others can serve to temper and balance the affluence of American life as exemplified in the late Albert Schweitzer's dictum: "It is only giving that stimulates."

Second, a security reason.—By the year 2000, there will be four times as many people in the developing countries as in the developed countries. We

cannot afford to be too little and too late with our development assistance. The idea that security is more than military might is not new. Seneca, nearly 2,000 years ago, warned the Roman Senate: "A hungry people listens not to reason nor is its demand turned aside by prayers."

The expectations of the poor are demanding fulfillment. Hopefully, some measure of their ambitions can be realized by peaceful means.

Third, a long-range economic reason.—An important way to expand our own economy in the future will be the creation of additional markets for U.S. goods and products. This aim is not entirely self-serving, because achievement of sustained economic growth by the hungry countries will depend upon their participation in world markets on a competitive basis.

This last goal of foreign aid has important implications for the inclusion of trade concessions in programs of foreign assistance.

Trade adjustments which appear to involve immediate sacrifices may, in the longer view, be far less costly than capital assistance given in traditional fashion. It is highly likely, in most instances, that provision of export markets based upon competitive advantage will be a most effective stimulus to development.

All too often, the United States and the other developed nations have seemed to regard the economic assistance as a short-term relief to countries which are temporarily poor. The experience of the past two decades indicates that assistance should become a part of a concept of the economic relations between unequally developed countries, which will last for many decades to come.

Finally, if this country is to deal seriously and productively with international development, three conditions must be fulfilled.

1. The American people must be convinced that the efforts merit investment of their taxes and that the efforts will be effective in meeting the overall problem.

2. The American people must have confidence in the substance of the programs which are implemented and in the arm of the government which is responsible for administration of those programs.

3. Foreign aid must be placed on a long-range continuing basis—not only in the planning and execution of programs but also in their evaluation.

In his farewell speech to the British House of Commons, Sir Winston Churchill said that mankind is facing the ominous task of choosing between Supreme Disaster or Immeasurable Reward. If we in the United States ignore or minimize the grinding poverty and hunger (as Mahatma Gandhi termed it, "the external involuntary fast") and the fading hope of the less fortunate of this earth, under the impression that we have chosen and are on the affluent pathway to Immeasurable Reward, we will be guilty of the most tragic misjudgment in the history of mankind.

Potentials for Tropical Agriculture

JUDGMENTS of the agricultural potential of tropical areas are as varied as the backgrounds of those who appraise it. They range from dismal pessimism to strong optimism. Typically, pessimistic viewpoints are documented by records of actual performance including failures of educated people with capital resources. Also cited are ineffectual struggles of peasant farmers against physical, biological, and economic forces beyond their control. In a bit of doggerel, Rudyard Kipling hinted at another aspect of the problem:

"The end of the fight is a tombstone white
with the name of the late deceased.
And the epitaph drear: A fool lies here
who tried to hustle the East."

The optimists cite tremendous basic resources of sunlight, energy, water, and soil and what has been done on tropical soils used by people having full access to science and industry. The high production of sugarcane in Hawaii and Queensland, rice in Taiwan and Australia, African oil palm in the Belgian Congo are just a few examples of yields that can be obtained.

From: *The World Food Problem*

CAREERS of PH. D.'S in the AGRICULTURAL SCIENCES

WALTER L. SLOCUM

IN 1965, the National Academy of Sciences-National Research Council (NAS-NRC) published a report by Lindsey R. Harmon summarizing the results of a nationwide study of selected aspects of the careers of 10,017 men and women who earned doctorates in various fields of science during the period 1935–60. The report presents information concerning doctorate holders in a number of scientific fields. The category, agricultural sciences, includes information from 536 persons who earned Ph. D. degrees in "forestry, agronomy, fish and wild life, horticulture, and animal husbandry, as well as fields carrying a specific agricultural label" (*4*).[1] Agricultural economists were classified as economists rather than as agricultural scientists.[2]

The sample was systematically selected from the doctorate records file of the Office of Scientific Personnel of NAS-NRC in such a manner as to provide representation for each field. Persons who received their doctorates at 5-year intervals during the period 1935–60 were included in the sample to provide a basis for comparing career patterns of older and younger scientists (*4*). These subsamples will be referred to as segments.

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[1] Italic numbers in parentheses refer to Literature Cited, p. 23.

[2] Personal communication from Lindsey R. Harmon, National Research Council, 1965.

Although the NAS-NRC report does not focus on the careers of agricultural scientists as a specific category, it does present considerable statistical information about the field. This paper is based mainly on information gleaned from that report.

Social Origins

IN relation to other fields, the proportion of holders of doctorates in the agricultural sciences whose fathers were farmers was exceptionally high—ranging from 44 percent for the 1955–60 segment to 53.6 percent for the 1945–50 segment. Because of the hereditary nature of farming, I would have expected an even higher proportion. Most contemporary farmers are sons of farmers, and persons who enter agricultural occupations have traditionally come from agricultural backgrounds. It is surprising to learn that approximately half of those who obtained their doctorates in the agricultural sciences were *not* sons or daughters of farmers. This ratio shows clearly that agricultural science is attractive to many persons who do not have an agricultural background. It also suggests that a farm background has not been a rigid requirement for graduate students in colleges of agriculture or forestry.

It would be interesting to know why persons with nonfarm backgrounds decided to take their Ph. D.'s in agriculture. In a letter to the author dated November 9, 1967, Lindsey Harmon offered the following comment:

"Regarding social origins, it seems reasonable that *farmers* are almost exclusively from farm backgrounds, because this is a declining portion of the population, with many children of farmers moving to the city. Agricultural *science* on the other hand, is expanding, and it probably draws people who have had a less intensive but nonetheless real association with agriculture through a summer on the farm, home gardening, etc. As the field includes fish and wildlife, and forestry, as well as tillers of the soil, there are plenty of opportunities for nonfarmers to have some childhood associations that are highly relevant."

The NAS-NRC study found that the parents of most doctorate holders were much better educated than their age peers, although the discrepancy was smaller for the younger Ph. D.'s than for the older ones—undoubtedly because of the general increase in educational attainments. In contrast, the fathers of the 1935–40 and 1945–50 segments in the agricultural sciences tended to have much less education than the fathers of scientists in other fields. In the 1935–40 segment, for example, 50.3 percent of the fathers of agricultural scientists had only an eighth-grade education or less, compared to 31.1 percent of the total sample. Mothers of agricultural scientists also tended to be less well educated than mothers of scientists in general, but the disparity was not as great as for the fathers. The explanation for the disparity is reflected in the fact that about half of the agricultural scientists came from farms, and, until recently, farmers have had much less interest in education and their educational attainments have been lower than those of town and city dwellers. This stuation, however, is now changing rapidly, at least in the State of Washington. A recent statewide study found that more farm boys than nonfarm boys aspired and expected to get a college education (*7*).

Employment

COLLEGES and universities were the predominant employers of Ph. D.'s in the agricultural sciences in 1962, especially for the 1945–50 segment (table 1). In this respect, the agricultural science

TABLE 1.—*Employers of agricultural scientists in 1962*

Employer	Percent of each segment		
	1935–40	1945–50	1955–60
College and university	47. 7	66. 7	58. 5
Business and industry	13. 2	12. 5	10. 1
Federal Government	21. 9	8. 9	14. 3
All other employers	17. 2	11. 9	17. 1
Number	151	168	217

Ph. D.'s resemble the great bulk of all respondents, 59 percent of whom were employed by colleges and universities.

It would be interesting to know why scientists who received their doctorates immediately after World War II were more heavily concentrated in colleges and universities than other segments were. It would also be interesting to know why a higher proportion of the 1935–40 segment than of the other two segments was employed by the Federal Government. Undoubtedly there were differences in employment opportunities available when these scientists first sought full-time professional employment. Also, there was a major expansion of the research activities of the U.S. Department of Agriculture during the period 1935–40 and a substantial growth in higher education immediately after World War II. Thus, there were probably relatively more attractive employment opportunities in the Federal Government for the oldest segment and more in the colleges and universities for the 1945–50 segment. Initial employment in a specific organization such as the USDA or a particular university, if a scientist receives adequate recognition, may lead to a career commitment in the organization.

Changes of Field

EVEN though attainment of a Ph. D. degree represents a very substantial commitment in terms of time, money, and effort, a fourth of the total sample of 10,000 scientists had shifted to another field by 1962. The retention rate for those who took a doctorate in the agricultural sciences was 72.6 percent, which may be compared with the high of 91.2 percent for the physical sciences and the low of 40.8 percent for "miscellaneous" biology (table 2).

Harmon suggests that one reason for a lower rate of field changing among scientists who received their doctorates in the agricultural sciences than among biologists is that they ". . . are considerably older and hence farther along in their careers at the time of the doctorate than is typical of the [biological] science fields" (*4*). Agricultural doctorates shifted to a wide variety of fields. In most cases these changes were probably changes from one department to another rather than changes in basic discipline. For example, agricultural chemistry and biochemistry, plant pathology and botany, entomology and zoology are not basically different pairs of fields.

TABLE 2.—*Changes in field of agricultural doctorates*

New field	Number	Percent
No changes	387	72. 6
Physiology	14	2. 6
Pharmacology	1	. 2
Biochemistry	14	2. 6
Microbiology	3	. 6
Botany	12	2. 3
Genetics	14	2. 6
Zoology	6	1. 1
Miscellaneous biology	4	. 7
Medical sciences	5	. 9
Social sciences	10	1. 9
Physical sciences	41	7. 7
Arts and professions	22	4. 1
Total	533	99. 9

Job Mobility

ALTHOUGH statistical information on job mobility by field is not presented in the NAS-NRC report, it states that relatively few job changes occurred among agricultural scientists. The fields with the highest rates of job mobility were identified as psychology, sociology, and political science.

It may be of interest to note certain general features concerning patterns of job mobility which probably are applicable to Ph. D.'s in the agricultural sciences as well as to other scientists. First, the highest rate of job changing apparently comes during the first 5-year period after the doctorate. However, except for the 1940 and 1945 segments, more than half of the scientists reported no job changes during their first 5-year period. Thus, there was considerable job stability even among young scientists. Second, the NAS–NRC report calls attention to the special impact of World War II on the job mobility patterns of scientists who received their doctorates in 1935, 1940, and 1945. The most pronounced effects were reported by members of the 1940 segment, who changed jobs more frequently during the first 5-year period than other segments. However, members of the 1935 and 1945 segments were also affected to some extent.

I am inclined to believe that a major factor in the greater job stability of agricultural scientists is that there is a tendency for them to be involved in research, especially research of a long term nature. It is not easy to move research involving experiments with plants or animals in a specific environment.

Work Roles

THE NAS-NRC report shows, for the total sample of 10,000, that full-time research activities were much more prevalent among younger scientists than among older ones. On the other hand, older scientists were four times as likely as their younger colleagues to be spending nearly full time in administration. There were only minor differences among the three segments in respect to the proportions who devoted various fractions of their time to teaching. We may infer that these patterns were characteristic of all fields, including the agricultural sciences, since the proportions of each segment of agricultural scientists engaged in research 50 percent or more of their time are consistent with the data for the total sample.

Earnings

IN most fields and age groups, those who devoted most of their time to teaching earned the least, whereas full-time administrators earned the most. Harmon has summarized the relationships as follows:

"The various functional groups may readily be compared on a percentage differential basis, with the 'teacher' group as the reference point of 100. The other groups, in ascending order of relative pay, are as follows: (*a*) the teacher-researchers, 111; (*b*) the researchers, 118; (*c*) the teacher-administrators, 125; (*d*) the 'unknown's', 132; (*e*) the mixed group, 134; (*f*) the researcher-administrators, 159; and finally (*g*) the administrators, 162. Although there are some variations, this hierarchy tends to hold across all [segments] and all fields" (*4*).

The data for agricultural scientists generally agrees with data for the full sample. Administrators were paid the most, and research-administrators

TABLE 3.—*Earnings of agricultural doctorates by major function performed in 1962*

Major function	Geometric mean for each segment		
	1935–40	1945–50	1955–60
Research 50 percent; teaching 50 percent	$10.392	$11.445	$9,661
Teaching 50 percent or more	10.910	11,717	9,433
Administration 50 percent or more	16.587	15.657	13.592
Research 50 percent or more	13,344	12.687	10,157
Administration 50 percent; research 50 percent	13,259	16,406	13,259

ranked next as in the total sample. However, there was not much difference between those who taught more than half-time and those who taught half-time and did research half-time (table 3).

Table 3 shows that among persons in the 1955–60 segment those who were principally teachers or who did research half-time and taught half-time earned almost as much as those who were old enough to be their parents. Average earnings of younger and older research-administrators were identical. Only among those who were in research or administration half-time or more was there a substantial advantage for the older Ph. D.'s. Except for those who were in research or administration half-time or more, the earnings of the 1945–50 segment were above those of the 1935–40 segment. These data indicate that age alone is not as highly valued as the functions performed. However, the relatively high salaries of the more recent Ph. D.'s reflect changes in the supply and demand situation. There is a high demand for a relatively short supply of young Ph. D.'s, and this condition has tended to increase their salaries disproportionately.

Discussion

THE fact that recruitment of agricultural scientists in the past has not been restricted to persons who have farm backgrounds suggests that the subject disciplines are not perceived as farm technology but have a broader appeal. The increasing sophistication of agricultural research and development suggests that the agricultural sciences will continue to draw Ph. D. candidates with both farm and non-farm backgrounds.

So far as future employment opportunities for agricultural scientists are concerned, it seems reasonable to expect that institutions of higher learning and government agencies will continue to be dominant. There appear to be no major impending developments in government, business or industry that would materially decrease the requirements for agricultural scientists by various types of employers. This prospect, when considered together with the relatively low mobility of agricultural scientists, suggests that there is sufficient stability in career patterns to warrant more detailed sudies of subfields. If such sudies are undertaken, it would be desirable, in my opinion, to obtain information which would make it possible to ascertain the extent to which the careers of scientists in various occupational specialties conform to a career model based on sociological research and theory.

Career patterns in specific professions have been studied by several sociologists (*2, 3, 6, 9, 10*). Some of the resulting publications are primarily statistical; others, such as sociologist Smigel's monograph, *The Wall Street Lawyer,* contain a great many excerpts from interviews.

Most scientists are employees of universities or colleges, and although there are differences in work roles, the scientist who works outside academia probably tends to regard the career of university scientist as his ideal. Consequently, it seems appropriate to use the occupation of university professor as a career model for all scientists. The sketch that follows is based on information from the literature supplemented by personal experience and observation:

Social Origins.—Since professional recognition comes through achievement, scientists may come from any stratum of society. The NAS-NRC data revealed that only about half of the Ph. D.'s in agricultural sciences were from farms. The intellectual nature of scientific work suggests that scientists are likely to have relatively well-educated parents. This was true for most scientists in the NAS-NRC study but it was less likely to be true for Ph. D.'s in the agricultural sciences.

Educational Experiences.—The work role of a scientist requires many of the same skills that are required in the scholar role of a student. Consequently, we may assume that most distinguished scientists had outstanding scholarship records in elementary and secondary schools as well as in college. However, there are apparently substantial differences between major fields insofar as high school grades in mathematics and science are concerned (*5*). It would be interesting to examine the influence of scholarship in more detail.

The career of a scientist typically begins when he is a graduate student, for it is his graduate department that selects him as a candidate for the doctorate. While still in graduate school, he learns many of the behavior norms and values of his occupational specialty. This is especially true for a graduate student who is fortunate enough to become the protege of an established scientist. The relationship of sponsorship by an established scientist to career progress should be explored.

Entrance into Professional Employment.—One who survives the rigorous screening of candidates by the university and earns a doctorate, especially from a prestigious department, enters professional life equipped with many advantages compared to an apprentice or an unskilled laborer. His professional skills and his knowledge of new developments in his field are superior in many respects to those of older scientists. Even so, he has to start a long way down the career line as an assistant professor or a junior scientist. His progress depends on achievement. As Caplow and McGee observed (*1*), a new Ph. D. does not "have it made." He has to gain acceptance as a full-fledged member of a department. Although most new Ph. D.'s now start their professional careers as assistant professors, they do not have tenure. At present the demand for scientists with Ph. D's is high and the supply is low. Consequently, their bargaining power is good and it is likely that few are insecure. It was not always thus.

Interorganizational Mobility.—Caplow and McGee reported that at major universities in the middle 1950's ". . . the majority of suitably qualified men must anticipate a notice of termination, a traumatic readjustment, and a new start leading quite possibly to a similar outcome" (*1*). At present, the rate of interorganizational mobility is quite high due to bidding by prospective employers for the inadequate supply of Ph. D's. As in earlier times, younger professors are believed to be more mobile than older ones. It would be desirable to investigate both the rate of and reasons for mobility.

Career Progress.—Nearly all scientists are employees. Thus, it makes sense to talk about promotions and demotions. In a university, the usual career line contains five steps: instructor, assistant professor, associate professor, professor and professor emeritus. Similar established career lines with well defined steps are found in government agencies and other work organizations.

Although most professors do some teaching, promotions are based to a considerable extent on scholarly work. The 1958 Caplow and McGee statement is probably still valid, but it would be desirable to verify this.

"It is neither an over-generalization nor an oversimplification to state that in the faculties of major universities in the United States today, the evaluation of performance is based almost exclusively on publications of books or articles in professional journals as evidence of research activity" (*1*).

Contrary to the prevalence of demotion among corporation executives, it is believed that nearly all doctorate holders eventually attain the rank of full professor or its equivalent. It would be desirable to investigate the extent to which scientists are obliged to move to an institution of relatively low prestige to become full professors (*8*).

The NAS-NRC study provides a great deal of useful information about some aspects of the careers of scientists. However, it is my judgment that research to verify or correct a career model such as I have outlined would be even more helpful to prospective agricultural scientists and counselors, and to graduate departments and employers.

LITERATURE CITED

(*1*) Caplow, Theodore, and McGee, Reece J.
1958. the academic marketplace, Basic Books, New York.

(*2*) Fichter, Joseph H.
1961. religion as an occupation, Univ. of Notre Dame Press, South Bend, Ind.

(*3*) Glaser, Barney G.
1964. organizational scientists: their professional careers, Bobbs-Merrill, New York.

(*4*) Harmon, Lindsey R.
1965. profiles of ph.d.'s in the sciences, Nat. Acad. of Sci., Nat. Res. Coun., Pub. 1293, Washington, D.C.

(*5*) ———
1962. on decision making in high school, The Bulletin, vol. 46, No. 277.

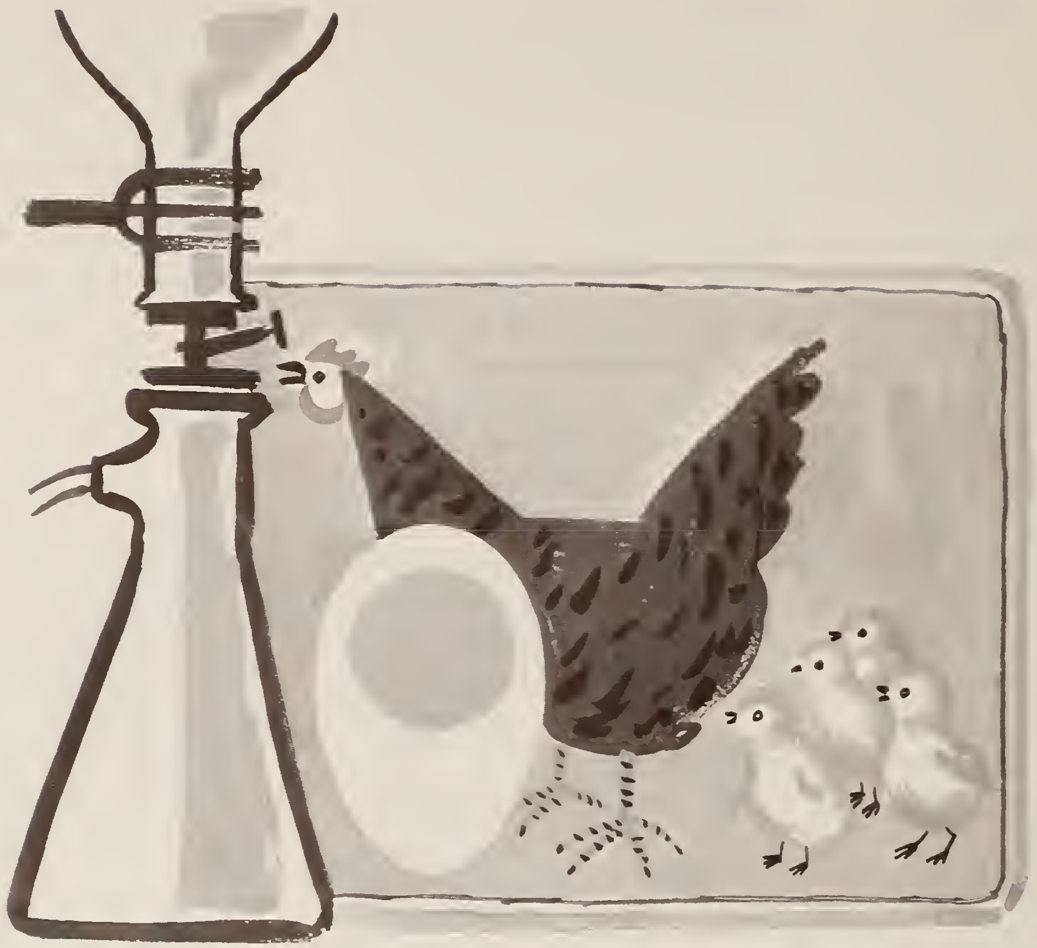
(*6*) Janowitz, Morris
1964. the proffessional soldier, The Free Press, New York.

(*7*) Slocum, Walter L.
1968. educational aspirations and expectations of students in rural washington high schools, Res. Bull. 690, Res. Center, Coll. of Agr., Washington State Univ.

(*8*) ———
1966. occupational careers, Aldine, Chicago.

(*9*) Smigel, Erwin O.
1964. the wall street lawyer, The Free Press, New York.

(*10*) Strauss, Anselm
1962. the professional scientist, Aldine, Chicago.



NUTRITION RESEARCH
in the Changing World of Agriculture
A CASE STUDY OF THE NEW JERSEY PROGRAM

HANS FISHER

TRENDS in nutrition research that have emerged during the past decade may have an important influence on future cooperative efforts between nutritionists and agricultural producers. These trends may eventually result in production recommendations that are based more on the interests of national public health rather than on the economic interests of certain commodity groups. Thus, in their new role, nutritionists would be providing effective guidance to the producer in terms of the nutritional needs of the consumer.

What is the nature and value of this new approach in nutrition research? What factors are contributing to the change of emphasis?

To begin with, during the 1950's—perhaps as a consequence of the great progress in bacterial disease control resulting from the discovery of antibiotics—attention became focused on certain aspects of public health problems related to metabolic disorders such as heart disease. Population studies as well as laboratory investigation soon gave rise to the suspicion that diet was implicated in the incidence and occurrence of this disease. The scientific literature was soon filled with reports showing a relationship between nutrients—particularly fatty acids—and blood cholesterol level. Hypotheses were developed

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which suggested a role for certain dietary unsaturated fatty acids in the control of blood cholesterol levels and possible atherosclerosis. (*1*) [1].

These new developments, in which a focus on diet entered medical research, prompted nutritionists at the New Jersey Agricultural Experiment Station to initiate studies designed to improve the nutritional worth of animal products to the human consumer. This shift in emphasis at the New Jersey Station may very well reflect the changing scene at the national level. Thus, a case study of certain aspects of New Jersey nutrition research may reflect the new array of problems nutritionists face and their hopes and aspirations for making new contributions to the health and well-being of the American people.

In our studies of the relationship between nutrition and atherosclerosis, we chose the domestic fowl as the experimental animal. This species stands out as one of the very few that develops atherosclerosis spontaneously, like man, even in the absence of special dietary or other stress. Moreover, the atherosclerotic lesion in the chicken is histologically difficult to differentiate from that found in man. According to Katz *et al.* (*10*), studies with the chicken approach "the dietary, metabolic and temporal prerequisites for atherogenesis in man." A number of dietary factors, including fatty acids, plant sterols, and level of protein, were shown to exert a significant influence on the incidence and severity of avian atherosclerosis (*3, 4, 6*).

Egg Fat Composition

DURING the course of these studies, we became interested in investigating the possibility of altering the lipid composition of hens' eggs. In the human diet, such eggs might be used to control blood lipid levels in man. After considerable difficulty in incorporating relatively large quantities of unsaturated fats into the diet of hens, we produced eggs in which the amount of unsaturated fatty acids (table 1) was increased severalfold (*2*). Unfortunately, our efforts to change the fatty acid content of eggs did not result in a lowering of the cholesterol content of the egg. Moreover, careful studies with the use of such unsaturated eggs showed that they were not beneficial in reducing the blood cholesterol level of humans ingesting them. It has since been established that the high degree of fatty acid unsaturation actually leads to an improved absorption of the cholesterol from eggs.

Despite our failure to produce eggs that might be of health value to the consumer, these studies pointed the way towards a greater awareness of the relationship between nutrition and public health problems.

In pursuing our studies relating to diet, blood lipids, and atherosclerosis, we discovered interesting beneficial properties of certain complex carbohydrates which normally are not considered important in preparing and planning balanced diets for man or animals. The first material to receive considerable attention was pectin—a substance present in respectable amounts in many fruits, particularly citrus, and in certain vegetables. A number of animal species, including man, show (table 2) a very significant reduction in plasma cholesterol when the diet contains cholesterol and is supplemented with pectin (*7*). Results of our studies (table 3) also suggest that pectin may exert its beneficial effect by reducing the absorption of dietary fat and

[1] Italic numbers in parentheses refer to Literature Cited, p. 28.

TABLE 1.—*Effect of different dietary fats on egg fat composition*

Fat supplement [1]	Fatty acid composition		
	Saturated	Linoleic acid	Arachidonic acid
	Percent	*Percent*	*Percent*
None	43. 2	4. 4	2. 1
Safflower, 10 percent	50. 2	18. 5	4. 4
Coconut, 10 percent	45. 5	4. 7	1. 7
Cottonseed, 10 percent	54. 0	22. 5	2. 9

[1] Supplement to a low-fat laying ration.

cholesterol through increased rate of food passage through the intestinal tract and greater lipid and cholesterol excretion in the feces (*8*). Pectin is not unique in exerting such antihypercholesterolemic (prevention of high blood cholesterol due to dietary cholesterol) effects. Several other materials, chemically unrelated to pectin but with similar physical charactertistics, have been shown to behave in an analogous manner (*9*).

Most recently we have found an active principle in oat hulls that reduces blood and liver cholesterol significantly but which seems to operate by a different mechanism from that of pectin. Unlike pectin, the oat hull factor does not increase the fecal excretion of cholesterol and total lipid. Moreover, there is a suggestion that the oat factor may reduce blood cholesterol levels even in the absence of dietary cholesterol ingestion. Some of the pertinent facts are summarized in table 4.

Disease-Resistance-Promoting Factors

THE studies which I have described represent but a single example of many efforts by some nutritionists to promote a better understanding of nutrition-related public health problems. Another interesting example is the research of Schneider at the Chicago Institute for Biomedical Research of the American Medical Association. Schneider has observed significant disease-resistance-promoting factors in certain foods (*11*). One such factor, SRF (mouse salmonellosis resistance factor) is found in several cereal grains, dried green or black tea, and in commercial dried egg white. The factor has been discovered to be synthesized by a species of Aerobacter bacteria in contact with the food source, rather than existing as an integral part of the food itself. The outstanding property of SRF is its chelating property. According to Schneider, this type of disease resistance factor does not belong in any category of required nutrients already recognized. It is not required for growth or maintenance, and no bacteriostatic or bacteriocidal effects are demonstrable. Schneider believes that "nutrition, as a science, has its proper home, not in biochemistry or physiology, which merely provide

TABLE 2.—*Effect of pectin on plasma cholesterol level of 4 animal species*

Species	Dietary cholesterol	Plasma cholesterol (mg./100 ml.)	
		Pectin diet	Control diet
Man	−	165± 9[1]	167± 6
	+	157±15	191±10
Chicken	−	111± 6	96± 4
	+	170±10	220±11
Swine	−	102± 5	108± 4
	+	133± 7	162±10
Rabbit	+	345±50	478±35

[1] Mean value with its standard error.

TABLE 3.—*Possible mechanism of the pectin-induced reduction in plasma cholesterol of chickens*

Diet supplement	Food passage time	Excreta measurement (dry excreta)	
		Total lipid	Cholesterol
	Minutes	*Percent*	*Percent*
None	170	4.9	0.9
Pectin	127	14.5	1.6

the tools of analysis, but in ecology, the study of the mutual relations between organisms and their environment."

The Unsolved Problems

FOR the purpose of our discussion, it suffices to state that there are as yet many areas of health-nutrition-related problems that invite investigation by nutritionists and at the same time demand the attention of the production arm within agriculture. Consider animal husbandry as just one example.

To a limited extent, animal husbandry has for the past few years shown some concern and limited interest in producing low-fat and high-protein milk, pork, and poultry. Present efforts, however, represent merely a step in the right direction and are far removed from coming to full grips with some of the major health-related nutritional problems discussed earlier.

The poultry industry, for example, could well spend some of the funds it currently uses to try and counteract adverse publicity in a search for a means of reducing the cholesterol content of eggs. This might be achieved by a drug screening program similar to one employed to screen anticancer drugs; through a selective breeding program for low-cholesterol eggs; and, of course, through an intensive effort to better understand the biochemical and physiological processes involved in the synthesis and deposition of cholesterol in the egg yolk.

Increased study of the processing of animal and poultry products is also greatly needed. It is possible, for example, to produce a defatted egg powder of high protein quality for the use of institutions and the baking industry and in candy manufacturing. Recent tests in our laboratories show that the rise in blood cholesterol usually associated with the consumption of eggs by normal human subjects (20–40 percent in our experiments) is prevented when a defatted egg product was used (manufactured by the VioBin Corp., Monticello, Ill.). The U.S. Army has been using a dry egg product manufactured by Roberts Dairy Co. (Omaha, Nebr.), in which 50 percent of the egg yolk is replaced with vegetable oil.[2]

It is my belief that animal nutritionists will be devoting more time in the next decade toward evaluating the nutritional balance of rations for farm animals. Their studies will result not only in more efficient and economical livestock production but also in the optimal nutritional worth of animal products to the human consumer.

Investigations of nutrition-health-related problems are by no means restricted to human application; such studies may have very useful implications for the production phase of animal husbandry. For example, we found that chicks raised for the first 4 weeks of life on a protein intake in excess of that necessary for maximum growth carried greater immunity to Newcastle disease than chicks fed a normal protein diet (*5*). Chicks prefed the higher than normal protein diet also had a lower mortality when challenged at weekly intervals with a known dose of Newcastle disease virus (fig. 1).

[2] Trade names are used in this publication solely for the purpose of providing specific information. Mention of trade names does not constitute guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement of other products not mentioned.

TABLE 4.—*Blood cholesterol-lowering properties of oats*

Dietary carbohydrate	Dietary (cholesterol)	Plasma cholesterol (mg./100 ml.)
Corn starch	—	112± 4 [1]
Corn starch plus oat hulls	—	101± 2
Corn starch	+	283±20
Ground oats	+	184±10
Dehulled oats	+	210±14
Corn starch plus oat hulls	+	199±12

[1] Mean value with its standard error.

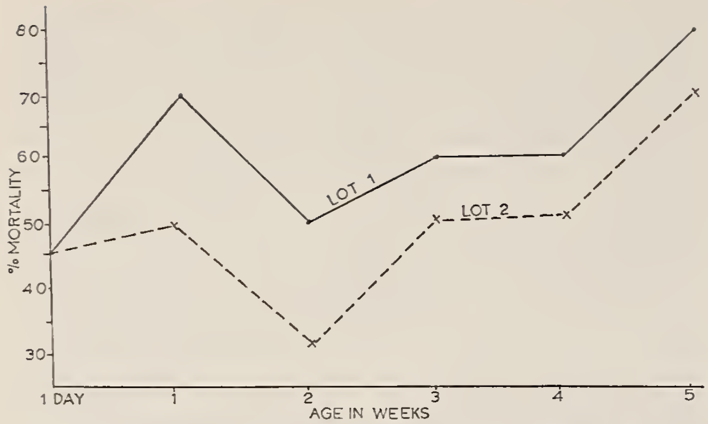


FIGURE 1.—Number of chicks that died expressed as a percentage of those inoculated at weekly intervals with a lethal strain of Newcastle disease virus. Until inoculation, the chicks had been fed diets containing either 22 percent protein (lot 1) or 28 percent (lot 2). The first group of chicks was inoculated immediately after hatching (1 day old).

Because of the relatively short time period as a function of life expectancy that normally elapses during the production of farm animals, very few studies have been carried out on the importance of metabolic disease, except insofar as the animal may serve as a model for a similar problem in man. Thus, the influence of proper nutrition on this area of important economic losses in animal production is as yet unexplored. According to reports from various diagnostic centers in this country and abroad, deaths in poultry from unexplained causes are estimated to exceed 50 percent of total deaths. It seems quite apparent, therefore, that nutrition research is already embarked in a new direction in which problems that relate to the health of animals and that of the consuming public constitute guidelines for the improved health of both.

Whether this new direction will gather speed and bring about in the near future desirable changes in animal products and a concomitant improved understanding of nutritional balance by the American public is by no means clear. Many nutritionists who could be working in this area of endeavor may be enticed to other pastures through the greater ease of getting research funds in nonagricultural areas. The system of funding in our agricultural experiment stations also does not encourage the early translation of new perspectives and trends into practice. There are thus realistic grounds for taking proper stock on the part of the agricultural leadership to insure that the necessary conditions will be met to support the new trends we have discussed so that, hopefully, the production branches of agriculture will be able to translate this research into early and effective implementation.

LITERATURE CITED

(1) AHRENS, E. H., JR., INSULL, W., JR., BLOMSTRAND, R., HIRSCH, J., TSALTAS, T. T., AND PETERSON, M. L.
1957. THE INFLUENCE OF DIETARY FATS ON SERUM-LIPID LEVELS IN MAN. The Lancet, May 11, pp. 943–953.

(2) FEIGENBAUM, A. S., AND FISHER, H.
1959. THE INFLUENCE OF DIETARY FAT ON THE INCORPORATION OF FATTY ACIDS INTO BODY AND EGG FAT OF THE HEN. Arch. Biochem. Biophys. 79:302–306.

(3) FISHER, H., FEIGENBAUM, A., LEVEILLE, G. A., WEISS, H. S., AND GRIMINGER, P.
1959. BIOCHEMICAL OBSERVATIONS ON AORTAS OF CHICKENS. EFFECT OF DIFFERENT FATS AND VARYING LEVELS OF PROTEIN, FAT AND CHOLESTEROL. Jour. Nutr. 69:163–171.

(4) FISHER, H., WEISS, H. S., AND GRIMINGER, P.
1963. CORN STEROLS AND AVIAN ATHEROSCLEROSIS. Proc. Soc. Expt. Biol. Med., 113:415–418.

(5) FISHER, H., GRUN, J., SHAPIRO, R., AND ASHLEY, J.
1964. PROTEIN RESERVES: EVIDENCE FOR THEIR UTILIZATION UNDER NUTRITIONAL AND DISEASE STRESS CONDITIONS. Jour. Nutr. 83: 165–170.

(6) FISHER, H., SILLER, W. G., AND GRIMINGER, P.
1965. RESTRICTED PROTEIN INTAKE AND AVIAN ATHEROSCLEROSIS. Nature, 207:4994:329–330.

(7) FISHER, H., GRIMINGER, P., SOSTMAN, E. R., AND BRUSH, M. K.
1965. DIETARY PECTIN AND BLOOD CHOLESTEROL. Jour. Nutr. 86:113.

(8) FISHER, H., SILLER, W. G., AND GRIMINGER, P.
1966. THE RETARDATION BY PECTIN OF CHOLESTEROL-INDUCED ATHEROSCLEROSIS IN THE FOWL. Jour. Atheroscler. Res., 6:292–298.

(9) GRIMINGER, P., AND FISHER, H.
1966. ANTI-HYPERCHOLESTEROLEMIC ACTION OF SCLEROGLUCAN AND PECTIN IN CHICKENS. Proc. Soc. Expt. Biol. Med., 122:551–553.

(10) KATZ, L. N., STAMLER, J., AND PICK, R.
1958. NUTRITION AND ATHEROSCLEROSIS. Lea & Febiger, Philadelphia. p. 61.

(11) SCHNEIDER, H. A.
1966. SOME NUTRITIONAL PARAMETERS IN THE ECOLOGY OF INFECTIOUS DISEASE. Proc. Nutr. Soc., 26:73–85.

GENETIC VARIATIONS in MILK PROTEINS

M. P. THOMPSON

POLYMORPHISM is a term widely used to describe the multiple forms in which either fat crystals or proteins, for example, can exist. Protein polymorphisms (substitutions or deletions of amino acids in the molecule) have been the object of investigation for some years, the study of which has been enhanced by zonal electrophoresis in starch-gel, paper, and other supporting media. Detection of polymorphisms of different proteins by electrophoresis depends in part on the electrical charge carried by the protein. Some noteworthy examples of polymorphisms of functional proteins are the blood proteins, hemoglobin, and transferrin—the genetic distribution of which has been thoroughly investigated. The study of such variations has often been a valuable tool in determining the cause of certain metabolic disturbances.

It is not surprising, then, that the study of genetic variation has been extended to include those proteins which are considered as nontransport, and the usefulness of these studies has become evident. For example, one may distinguish between species of fish by examining the genetic differences in the meat proteins. This is especially useful when a dealer claims that he is selling trout fillets when in fact they are carp fillets. And from the processing viewpoint, there is the possibility that certain genetic forms of protein in food products might impart more desirable characteristics to the product than would other forms.

It is also not surprising that those who have discovered genetic variation in food proteins have regarded the system in which they are discovered as a dynamic, biological system. Often, from a basic or applied research problem on a commodity, discoveries of considerable value to other areas of research, in our case biochemistry, have emerged. Such is the case with milk. Although this remarkable substance is commonly regarded as a nutrient source or something to be made into delicious byproducts, from a chemical point of view it is far more tempting to regard it as a biological fluid. The latter we will do for the remainder of this discussion.

Proteins of the milk system have been broken down into three classes—those contained in the whey, the caseins, and those on the fat-globule

surface (membrane). Whey proteins, β-lactoglobulin, α-lactalbumin, and immune globulins have been studied for decades. Until the serendipitous discovery of β-lactoglobulin variation (two forms—*A* and *B*) by Aschaffenburg and Drewry in 1955, no variations of any type had been reported.[1] This astonishing discovery made possible exhaustive physical and chemical studies of the β-lactoglobulins which heretofore had been complicated by a system containing—unbeknown to researchers—two molecular species. Other researchers were prompted to examine the milk system in an attempt to discover further polymorphisms in other milk proteins. Blumberg and Tombs did exactly that when they discovered in Icelandic White Fulani cattle that α-lactalbumin existed in two forms, *A* and *B*, as disclosed by paper electrophoresis.[2] Strikingly, α-lactalbumin is now known to be biologically active; it is the *B* protein of the lactose synthetase system which is responsible for the enzymatic synthesis of lactose in the mammary gland.[3]

Since the precedent of polymorphism had now been established in the whey proteins, Aschaffenburg turned his attention to a study of the possibility of variation in the caseins. Five years after his discovery of β-lactoglobulin variation, he again surprised workers in milk protein chemistry by announcing that β-casein, the second most abundant milk protein, existed in three forms—*A*, *B*, and *C*. Concurrently with the studies of Aschaffenburg,[4] our laboratory was investigating the fraction of casein termed α_s (the fraction that is precipitated by calcium ions, but is stabilized against precipitation by another casein termed χ-casein). The purpose of this investigation was to develop methods of purifying the protein. Eventually, α_s-casein (now termed α_{s1}-) polymorphism was discovered,[5] adding to the growing number of genetic variants discovered in the milk system. Finally, χ-casein, one of the more important and formidable milk proteins, was found to exist in two forms—*A* and *B*.

[1] Aschaffenburg, R., and Drewry, J. Occurrence of Different Beta-Lactoglobulins in Cow's Milk. Nature, 176: 218, 1955.

[2] Blumberg, B. A., and Tombs, M. P. Possible Polymorphism of Bovine α-Lactalbumin. Nature, 181: 683, 1958.

[3] Brodbeck, U., and Edner, K. E. Resolution of a Soluble Lactose Synthetase Into Two Protein Components and Solubilization of Microsomal Lactose Synthetase. Jour. Biol. Chem., 241: 762, 1966.

[4] Aschaffenburg, R. Inherited Casein Variants in Cow's Milk. Nature, 192: 431, 1961.

[5] Thompson, M. P., Kiddy, C. A., Pepper, L., and Zittle, C. A. Variations in the α_s-Casein Fraction of Cow's Milk. Nature, 195: 1001, 1962.

The foregoing briefly sums up the results of 10 years of study on genetic variation. Perhaps now we should ask ourselves what the value of such research has been. From an agricultural viewpoint, we have now been able to seriously consider the chemistry of milk proteins with a consciousness of genetic variants. This knowledge has enabled the chemist to establish how the milk proteins interact to make milk milk, and not a highly disorganized system. From a biochemistry viewpoint, the implications of the studies have been far more significant: studies relating to the mode of inheritance, linkage of genes, genetic code, possible origin of domestic cattle, and differences in chemical-physical properties of protein variants have emerged. Let us consider these.

Mode of Inheritance and Breed Specificity

THE inheritance pattern of the milk proteins—β-lactoglobulin and α-lactalbumin of whey, and α_{s1}-, β-, and χ-caseins—is controlled by a series of multiple-allelic autosomal genes with no dominance: This is to say that if an *A/A* genotype is bred to an all B/B genotype, all of the offspring will be *A/B*. If, however, *A/B* is bred with *A/B* the offspring will be A/A, A/B, B/B.

Extensive investigations on the extent of breed specificity of milk protein polymorphs have presented some interesting results. First, β-lactoglobulin *A* and *B* variation is universal among breeds of cattle studied—Western or domestic breeds (*Bos taurus*) and Eastern (*Bos indicus*), found in India and Africa. However, additional variants have been found in Jersey and French Falamande cattle where β-lactoglobulin *C* and *D*, respectively, have been observed. On the other hand, α-lactalbumin *A* has been observed only in zebu (*Bos indicus*) cattle, while the *B* form is universally prevalent. The importance of this observation will be considered later.

The caseins possess far more breed specific variation than do the whey proteins. β-casein is an excellent example of this. Although the *A* variant (and the author confesses oversimplification of the term "*A* variant," because it is now known to exist in three forms, A^1, A^2, and A^3) is universal among *Bos taurus* and *Bos indicus*, *B* is abundant only in Jersey milks, but is sprinkled throughout Holstein, Brown Swiss, and African and Indian zebu. β-casein *C* is never observed in zebu cattle, but is present in the

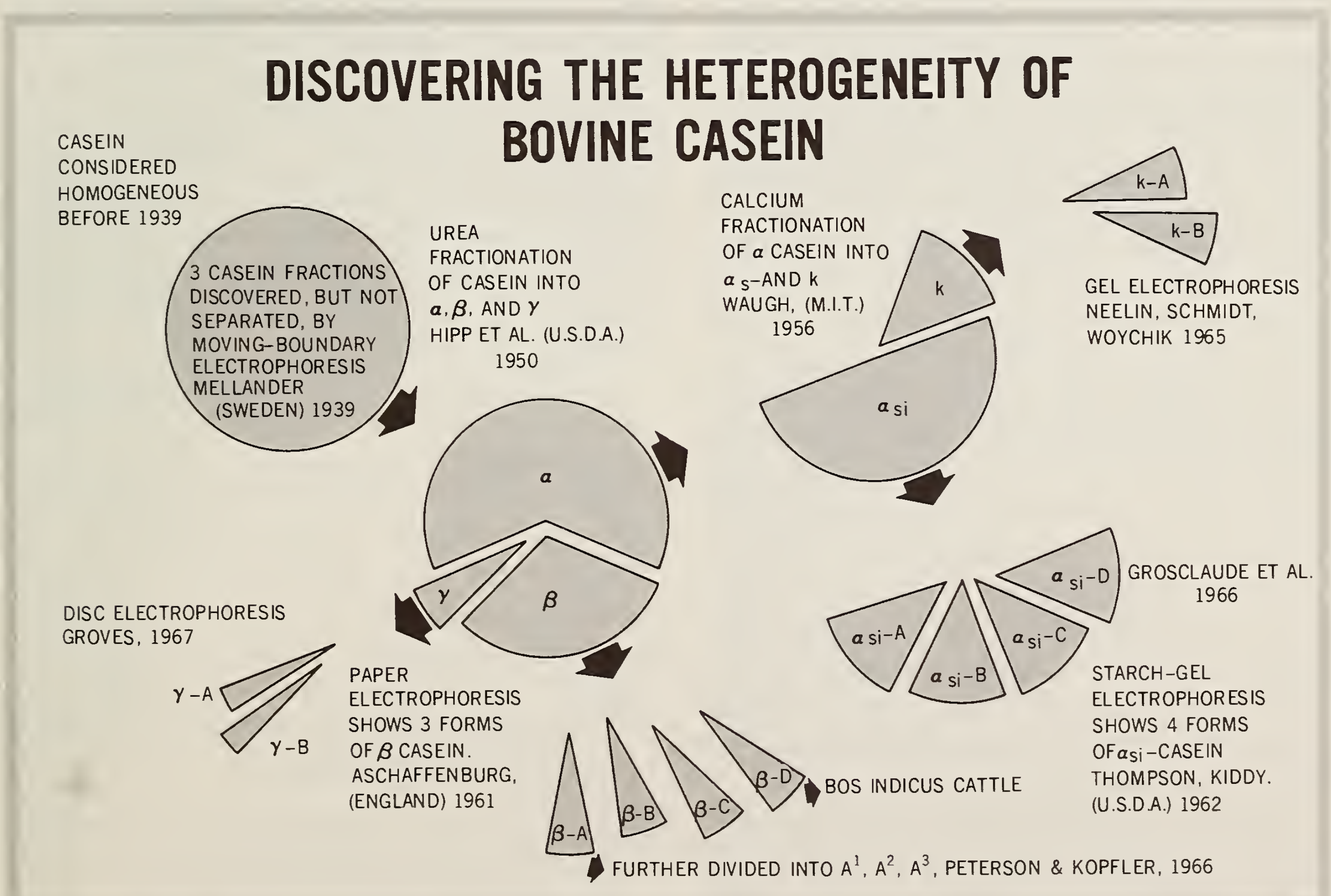
milks of Guernsey and Brown Swiss, and is totally absent in Jersey, Ayrshire, and Holstein—to name a few. Although zebu are devoid of β-casein *C*, they have an additional variant which has been termed *D*. An interesting point to emphasize here is that, in general, more variation in β-casein is observed in Western breeds of cattle than in the older Eastern breeds.

Zebu cattle predominantly secrete milk containing α_{s1}-*C* caseins, but in European and American breeds the *B* form is present about 90 percent of the time. In all cattle studied to date, with the exception of Ayrshire and Shorthorn, both the *B* and *C* variants are observed; in those breeds we found only the *B* variant. α_{s1}-*A* is the rarest of all the casein variants and, as we will discuss later, it is one of the most unique protein variants found in nature. The *A* protein appears to be limited to a single blood line of Holstein cattle, and perhaps may be a mutant of recent origin. Some Danish workers have reported what appears to be the *A* variant in RDM cattle; however, similar electrophoretic mobility to authentic *A* does not give proof of identity; that is, the variants may differ in amino acid composition.

Lastly, χ-casein variation (*A* and *B*) is universal among all breeds of cattle studied. Interestingly however, the *B* form predominates in Jersey cattle.

Linkage of Genes

LINKAGE of β- and δ-chains of hemoglobin and linkage of egg white proteins has been observed in the occurrence of these proteins. The term "linkage" is defined as the tendency of genes to be passed on, in groups, to the next generation. If, however, phenotypes (or combinations) are seen which do not fit into the exclusion dictated by linkage, then the term "crossing over" is used. With the caseins (and I use the simplest example of this in the milk system), the usual combination of α_{s1}-Cn to β-Cn is α_{s1}-Cn^B, β-Cn^A, although other combinations such as α_{s1}-Cn^C, β-Cn^A are not uncommon particularly in *Bos indicus*. However, English workers in collaboration with the U.S. Department of Agriculture, as well as French researchers, noted that such combinations as



α_{s1}-Cn^C, β-Cn^B rarely if ever occur. These were regarded as "forbidden" combinations, and their rarity was explained on the basis of linked genes, which simply means that the loci of α_{s1}-Cn and β-Cn are extremely close. The usefulness of linkage information becomes obvious. First, it is another example of the phenomenon; secondly, the information may be used for chromosomal mapping of inherited characteristics of the bovine, a procedure normally carried out in fruit flies (*Drosophila*) and certain bacteria.

The Genetic Code

MOLECULAR biologists and geneticists have attempted to describe, in molecular terms, the factors that allow certain amino acid substitutions to occur within a protein molecule. The language of the cell, the genetic code, is such an attempt. The words of this language are composed of a four-letter alphabet representing the bases of ribonucleic acid (RNA): *A*-adenine, *C*-cytosine, *G*-guanine and *U*-uracil. For example, the amino acid difference between α_{s1}-casein *B* and α_{s1}-casein *C* are +1 glutamic acid and −1 glycine in *B* and −1 glutamic acid and +1 glycine in *C*. This is represented by the triplets GAA/GGA of the genetic code and is a familiar substitution found in hemoglobin, tobacco mosaic virus (TMV) coat protein, and the reverse substitution in tryptophan synthetase. Of course, the *B* and *C* variants of α_{1s}-casein represent an elementary example of the genetic code. The α_{s1}-*A* variant is not describable by the genetic code for it is devoid of at least eight amino acids which are apparently deleted in a single segment of the protein molecule. This is a far more reacting mutation than we have seen with the α_{s1}-*B* and *C* variants, one involving the deletion of a segment of deoxyribonucleic acid (DNA) containing about 24 base units. This deletion ultimately expresses itself in the absence of eight amino acids which we think are in sequence. Consequently, we have a protein deserving of further study because it is not a variant in terms of simple amino acid substitutions or, as will be discussed, does it behave in physical terms like an α_{s1}-casein.

Assignment of triplet coding to β-lactoglobulins *A* and *B*, which differ by two pairs of amino acids, is not easy. However, the *B* and *C* variants of this protein differing by histidine/glutamine, can be described as involving triplets of *CAU/CAA* or *CAC/CAA*. Clearly, however, the milk proteins offer excellent examples of amino acid substitutions which coincide with already observed substitutions and other systems which are predictable in genetic terms.

Origin of Western Cattle

CIVILIZATION of the Western world has been typified by the domestication of cattle and dogs, and in an attempt to decide the route of migration of man from the Middle East, anthropologists have often used the remains of domestic animals and the appearance of artifacts to ascertain that route. Unfortunately, time has a way of eliminating many remains that would be valuable in making such a decision. An alternative method is to examine the living and to observe the frequency of occurrence of a particular substance in an attempt to delineate the origin of a particular plant or animal. This is often done with blood proteins, hemoglobin and transferrin—as well as with blood groups—as a reliable guide for origin. Sen *et al.*,[6] for example, have noted that the frequency of occurrence of hemoglobin *B* in zebu cattle is sufficiently similar to that of the Jersey breed to suggest a possible relationship between Jersey cattle and the more primitive zebu. Furthermore, Stormont[7] remarked that "In my opinion the occurrence of the $A_1D_2Z^1$ blood group in Channel Island cattle (Guernsey and Jersey) is the strongest evidence that one of the ancestral links of those breeds traces to one of the breeds of *Bos indicus*."

Because of the ease of obtaining milk for analysis, we considered that a study of the phenotypes of milk proteins might yet be another valuable way of tracing the origin of Western breeds of cattle. Let us first consider the whey proteins, β-lactoglobulin and α-lactalbumin. The former is found universally among *Bos taurus* and *Bos indicus* in the forms *A* and *B; B* predominates in *Bos indicus*. Because the *C* (Jersey) and *D* (French and German cattle) variants are found in Western breeds only, the value of β-lactoglobulins in delineating the origin of breeds

[6] Sen, A., Roy, Debdutta, Bhattacharya, S., and Deb, N.C. Hemoglobins of Indian Zebu Cattle and the Indian Buffalo. Jour. Anim. Sci., 25: 445. 1966.

[7] Stormont, C., Univ. of Calif., Davis. Personal communication, 1966.

is essentially zero. Although α-lactalbumin *A* is found in zebu cattle, we have not yet observed it in Western breeds. If, however, Jersey and zebu are closely related, as Sen *et al.,* and Stormont suggest, it may yet be discovered in Western breeds. Frankly, I doubt it.

Because we can essentially rule out the value of phenotypes of whey proteins we should, of course, analyze the data obtained from casein phenotyping. Although χ-caseins *A* and *B* are fairly well distributed among *Bos indicus* and *Bos taurus,* a trend clearly emerges from a study of the frequency of occurrence of α_{s1}-caseins *B* and *C* and β-caseins *A, B,* and *D*. The gene frequency of α_{s1}-*C* is high (0.95) in Indian zebu cattle but decreases decidedly to 0.85 in East Africa. However, the *B* variant predominates in *Bos taurus* or the Western breeds. Thus, we see from the subcontinent of India to East Africa to Western Europe a progressive decrease of α_{s1}-*C* and, conversely, an increase of α_{s1}-*B*. Additionally, β-casein *D*—never seen in Western Europe or America—occurs in both Indian and East African zebu. Historically, it has been suggested that African zebu (Boran and Ankole) came from India; our observations strenthen this suggestion.[5]

It is tempting to speculate as to the origin of Western breeds of cattle and their relationship to man over a period of several centuries. But we are admonished to be cautious about our data for two reasons: (1) Our results are too often tainted by preconceived notions, and (2) statistical evidence is rather scarce. More data must be accumulated from a greater variety of breeds of reasonably well-established purity and ancestry. This, I feel, is imperative.

Properties of Genetically Different Milks

As would be expected, from previous knowledge of other polymorphic protein systems, the casein variants are not identical in physical behavior. α_{s1}-Casein *A,* the rarest of the α_{s1}-casein variants, for example, is soluble in 0.4 *M* calcium chloride from 0°–30° C. while the *B* and *C* variants are not. This protein is also stabilized with χ-casein with more difficulty than *B* or *C* over a range of calcium chloride concentrations. Perhaps these observations on isolated α_{s1}-casein become more meaningful when we consider the influence of this variant on the physical behavior of the milks containing the variant. First, cottage cheese prepared from the milk yields a soft curd coagulum which cooks out with difficulty, an obvious economic defect. Second, the α_{s1}-*A* containing milks generally show low stability to heat processing, another obvious economic defect. Third, generally instability of the micellar system can be explained, in part at least, by the low level of water of solvation (1.4 g. water/ g. protein) of casein micelles of α_{s1}-*A* milks as compared to high solvation (1.8–2.2 g. water/ g. protein) for normal milks. Colloidal (micelle) stability depends in part on the level of water solvation as well as on the electrical charge of the colloid.

Evidently the α_{s1}-*A* variant is the most peculiar in chemical composition and physical behavior in the isolated and natural systems. The normal variants do not behave as peculiarly. I would suggest, therefore, that processing variations in individual milks are due in part to protein polymorphisms as well as to the variation of natural salts in milk.

Currently we are engaged in research on the studies of casein micelle stability as affected by genetic variation and quantity of casein components, on the one hand, and on the other, the influence of the above on the binding of calcium and phophorus in the micelle system.

[5] Aschaffenburg, R., Sen, A., and Thompson, M. P., Genetic Variants of Casein in Indian and African Zebu Cattle. Comp. Biochem. Physiol., 25: 177. 1968.

FORUM

REVIEW OF THE REVIEWERS

CREATIVE activity in any field of endeavor is punctuated by an occasional discord in ideas or judgments. As a rule, it is a productive discord, for "the truth comes from a clash of two opinions." In turn, criticism performs a highly useful function either by adding final touches to the work or by preventing pollution of the world by undesirable debris.

At times, however, a clash of opinions does not herald the arrival of truth. Suffice it to recall the appraisal of Pasteur's fundamental findings by Nägeli as "incorrect interpretation of poorly conducted experiments." An untold number of similar blunders of criticism have caused anguish to the author, everlasting embarrassment to the reviewer, and at times irreparable loss to recorded knowledge. A few irresponsible comments arrested for many years the activity of one of the most outstanding microbiologists, Sergei Winogradsky.

The reasons for miscarriages in criticism are many: Influence of religious or political credos, preconceived notions, the Procrustean tendency to maintain the *status quo*. Theodore Roosevelt described very well the chief obstacle to scientific progress: "The capacity of the human mind to resist the introduction of a new knowledge is nothing short of marvelous."

Author-Reviewer Conflicts

During recent years much has been done in the United States to minimize frustrating accidents in the realm of scientific writing. Many technical journals have sheltered their contributors against adverse literary encounters by erecting a shield in the form of "Instructions to the Authors." In a direct manner the author's privileges were defended by Forscher's comprehensive essay "Rules for Referees" (*Science,* vol. 150, 1965). These publications have helped to deescalate the author-reviewer conflict and have benefited all concerned—author, editor, and reader. Nevertheless, they have failed to stress a few intrinsic details that often contaminate the editorial "barrel of honey with a spoon of tar." The omission is elaborated upon in this note.

To begin with, one should touch upon the eloquence of reviewers. According to the claim of the French people it is tone, not verbal content, that carries the message. Criticisms are expressed in tones varying widely in pitch and volume, some of them in definite conflict with the principles of harmony. Provocations of caustic comments by the reviewer are numerous. They range from burnt toast at breakfast to the reviewer's desire to inflate his own ego or to ease wounds suffered in unrelated encounters. A reviewer of this disposition does not perform his duty, but accommodates himself at the expense of the author, the society that supports the periodical, and the profession of psychoanalysis.

Verbal Deodorants

The enormous flexibility of the English language provides an unlimited variety of sprays of verbal deodorants that permit a transmission of a reviewer's cutting message in soft-pedaled recitative rather than ear-splitting rhapsody. Regulations of the English House of Commons set limits to brightly colored rhetoric, but they do not change the intrinsic thrust of speeches delivered under cloak of polite equivalents. For example, it is forbidden to call an M.P. a liar, but the same idea can be incorporated in a sentence: "The honorable gentleman is perpetrating a terminological inexactitude."

The disparity between the viewpoints of the author and the reviewer at times approaches an angle of 180°. A reviewer usually desires to see the report as a landscape in which everything is pruned, trimmed, and arranged in a definite geometric pat-

tern. A scientific article often deals with but a small part of a deep forest surrounded by dense jungle of ignorance. Under such conditions, an investigator is forced to use a speculative approach, one of the essential tools of research which is seldom appreciated by reviewers.

Josiah Royce, one of the greatest speculative minds that America has produced, pointed the proper way to an objective as follows: "Not to demonstrate in fair and orderly array, from one principle or axiom what must be . . ., but to use every and any device that may offer itself, general analysis, special example, comparison, and contrast of cases." In the beginning of the beginnings of most great discoveries there was neither word nor deed, but a thought, i.e., a speculation. In some cases the soundness of the introduced hypothesis was confirmed by experimental evidence in a period of days; in other instances—after several centuries. Neither the mumbling of Galileo, *"Eppur si muove,"* nor equations of Einstein were underlain by statistical analyses. On one occasion the confirmation of the correctness of a speculative idea came in the form of a thunderous release of energy.

These ideas coincide very closely with suggestions expressed by Dr. Forscher: "The journal that attempts to avoid controversy, to publish only papers that are 'right', or to limit discussion and speculation defeats its purpose."

A few decades back, criticisms were confined to printed pages and the critic was exposed to a counterattack of the author as well as the forum. Occasionally a caustic appraisal of the work rewarded the author with a recognition which he would have failed to receive in the absence of criticism. Within the realm of scientific literature, this fair, egalitarian relationship has undergone in recent years a highly undesirable change through the introduction of an unidentifiable, hence invulnerable, and at times irresponsible critic—the anonymous referee. There is more than one reason to claim that the underground appraisal of submitted papers, adopted by many English language periodicals, is very harmful, unethical, and totally superfluous.

Academic Dignity

A procedure involving an element of secrecy is hardly compatible with academic dignity. It provides unrestricted possibility for negligent or prejudicial appraisal of contributions and the use of uncalled for language. Anonymous criticisms often convert the bright atmosphere of spontaneity into a smog of Nietzschean *ressentiment,* an attitude of hostility and destructiveness. In the unequivocal opinion of Forscher, when verbatim comments of a reviewer are transmitted to the author, "the name of the referee should also be transmitted."

To conclude: The referee is not a creator of new values, but an intermediary between the producer and the consumer of goods. His function is either to accept and place on the market attractively arranged merchandise, or to reject it as unsuitable for his shop. In a fair transaction, a reviewer who disagrees with the contents of a paper to the extent justifying caustic comments should restrain himself from casting pearls of wisdom and limit his labors to a polite statement: "Unavailable for this particular journal." If the contribution deserves to be reviewed, neither derogatory remarks nor anonymity should be required.

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